ROAD SAFETY DIVERSION PLAN FOR THE TRANSPORTATION OF PRECAST SEGMENT AND ANALYSIS OF SAFETY PERFORMANCE RATING IN CONSTRUCTION INDUSTRY

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ROAD SAFETY DIVERSION PLAN FOR THE TRANSPORTATION OF PRECAST SEGMENT AND ANALYSIS OF SAFETY PERFORMANCE RATING IN CONSTRUCTION INDUSTRY

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of the degree of

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in

Safety Engineering

by

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under the supervision of

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and

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May, 2016

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CERTIFICATE

This is to certify that the work contained in the thesis entitled ***"Road Safety Diversion Plan for the Transportation of Precast Segment "*** submitted by ***Mr. Sourav Mohanty*** (Roll No: 214ch2528) is a record of original research carried out by him/her under my supervision and guidance in partial fulfilment of the requirements for the award of the degree of **Master of Technology in Safety engineering** in the department of Chemical Engineering, National Institute of Technology Rourkela is an authentic work carried out by him under my supervision and guidance. Neither this thesis nor any part of it has been submitted for any degree or diploma to any institute or university in India or abroad.

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DECLARATION OF ORIGINALITY

I, Sourav Mohanty, Roll Number 214CH2528 hereby declare that this thesis entitled "***Road Safety Diversion Plan for the Transportation of Precast Segment and Analysis of Safety performance rating in Construction Industry***" represents my original work carried out as a postgraduate student of NIT Rourkela and, to the best of my knowledge, it contains no material previously published or written by another person, nor any material presented for the award of any other degree or diploma of NIT Rourkela or any other institution. Any contribution made to this research by others, with whom I have worked at NIT Rourkela or elsewhere, is explicitly acknowledged in the thesis. Works of other authors cited in this thesis have been duly acknowledged under the section "References". I have also submitted my original work records to the scrutiny committee for evaluation of my thesis.

I am fully aware that in case of any non-compliance detected in future, the Senate of NIT Rourkela may withdraw the degree awarded to me on the basis of the present thesis.

May 23, 2016

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ABSTRACT (SECTION 1)

The overall traffic management plan is designed and intended to specify adequate safety measures in advance against identified hazards and stipulated implementation of the said safety measures to ensure safe movement of traffic during the construction operations of Delhi Metro Rail Project. The objective of safety standards is to provide safe travel to the drivers of vehicles plying on the Project Highway at all times of the day throughout the year and provide protection to the Project workers when they are on the work. This overall traffic management plan delineates the safety standards in terms of Construction zones, Signs and Safety measures in work zones and during normal operations. This manual is designed for a broad inter-disciplinary audience consisting of people involved in preventing work and road traffic injuries at work zones on roads and highways. Construction Zones are an integral part of any road construction system. The safety practices in construction will, therefore, be oriented towards reducing conditions, which lead to such hazards and consequent stress whereby risk of accident increases. Safety measures will be aimed at avoiding hazardous conditions especially in work sub zones where major construction activities are going on. For all purposes, the entire stretch will be treated as work sub zone.

The report is divided into 5 sections i.e., Introduction, Literature Review, Description of Model, Implementation and Transportation of Precast Segment. The Literature Review section contains the details regarding Traffic Management Plan. The Description of Model Section contains the design and the detail process how the diversion plan is processed to prevent the road accidents and by which the transportation of Precast segment can be done from the stacking point to the point of erection with an objective to minimize or alleviate disruptions to existing travel pattern and other activities while re-organizing through / regional movements and implementing temporary measures in the influence zone of the project area at the instance of Delhi Metro Rail Corporation (DMRC) for construction work at Construction of viaduct from P11-18 to P11-26 of CC-77 – Construction of viaduct and Stations for YMCA - Ballabhgarh Extension of Dehli MRTS Phase-III. . The implementation Section contains the outcome of the proposed plan for the diversion.

ABSTRACT (SECTION 2)

Safe working of any construction industry and its operation is the premier priority and it is a cumulative effort of the safety officer, manager, head of department of concerned department, employees, supervisors and workers etc. This provides a better outcome in end in minimizing the accidents. The comparative result and the safety performance for the past few year accidents can help to minimize the accident scenario. Hence we require some techniques for determining the safety measures and to provide safety performance measuring rating for the construction industry. Such techniques and type of rating help to monitor to identify the weakness in implementation of safety program in the industry and providing a more sturdy safety system program. The safety rating and measurement of safety performance is beneficial to all people in management to know the progress of safety culture in their industry. Severity of the accident can be well identified by using the most powerful tool that is by the process of Quantitative monitoring. In this method we can get a proper value and detail idea about the most and least cause of unsafe work that is caused in terms of safety. This study compares the accident detail program of different industry for the past few years with an attempt to better understand the progress of safety culture in the industry. In this thesis we are basically focusing on the quantitative measures of various programs.

KEYWORDS: Quantitative monitoring, Safe T Score, Man-Hours Worked, Reportable Lost Time Injury, Disabling Injury and Safety Culture.

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SECTION 1

CHAPTER 1

INTRODUCTION

Chapter 1 *Introduction*

1.1. GENERAL

Road safety is considered a prominent topic in our country. Every year 1.2 million of people are slayed and between 20 and 50 million people are injured in road accidents. If current drifts continue road traffic accidents are foretold to be third leading donor to the global load of Disease and injury by 2020.

Undoubtedly India has been achieving a top place in number of fatalities every year because of its flaws in road safety. This topic is on highlight now a days as a major social anxiety around the world especially in India.

Thousands of people are injured when traffic has to go through road construction or maintenance works. The numbers of construction zone injuries and fatalities are expected to rise even higher.

Road construction regions show a lethal hazard for workers, motorists, and pedestrians. This hazard is initiated by high speed driving, impatient drivers, and also due to widespread traffic jams. With this we can add up heat, driving stress, and long stretches of highways which are under construction - creating a way for extreme driving hazards for motorists and road workers alike.

Road works operations need to be sensibly planned and administered to evade accidents. Most accidents within the minor plant and equipment are triggered by improper usage and poor maintenance. Management guidelines of construction zones are very inclusive.

1.2. ROAD SAFETY

Road safety is a serious issue presently as it predicts a man's safe climate while he is using the road network for fulfilment of specific jobs. The users of a road include pedestrians, motorists, cyclists, their passengers, and passengers of on-road public transport, mainly buses and trams. Best-practice road safety tactics focus upon the deterrence of serious injury and death crashes in spite of human fallibility. Safe road design offers a road environment which safeguards vehicle speeds within the human tolerances for serious injury and death wherever skirmish points exist.

The basic technique of a safe system is to ensure that in the event of a crash, the impact drives remain below the threshold likely to produce either death or serious injury. This threshold will differ from crash scenario to the same, depending upon the level of guard offered to the road users involved. For example, the probabilities of survival for an unprotected pedestrian hit by a vehicle reduce rapidly at speeds greater than 30 km/h, whereas for a correctly restrained motor vehicle occupant the grave impact speed is 50 km/h (for side impact crashes) and 70 km/h (for head-on crashes). Public safety is very important in driving.

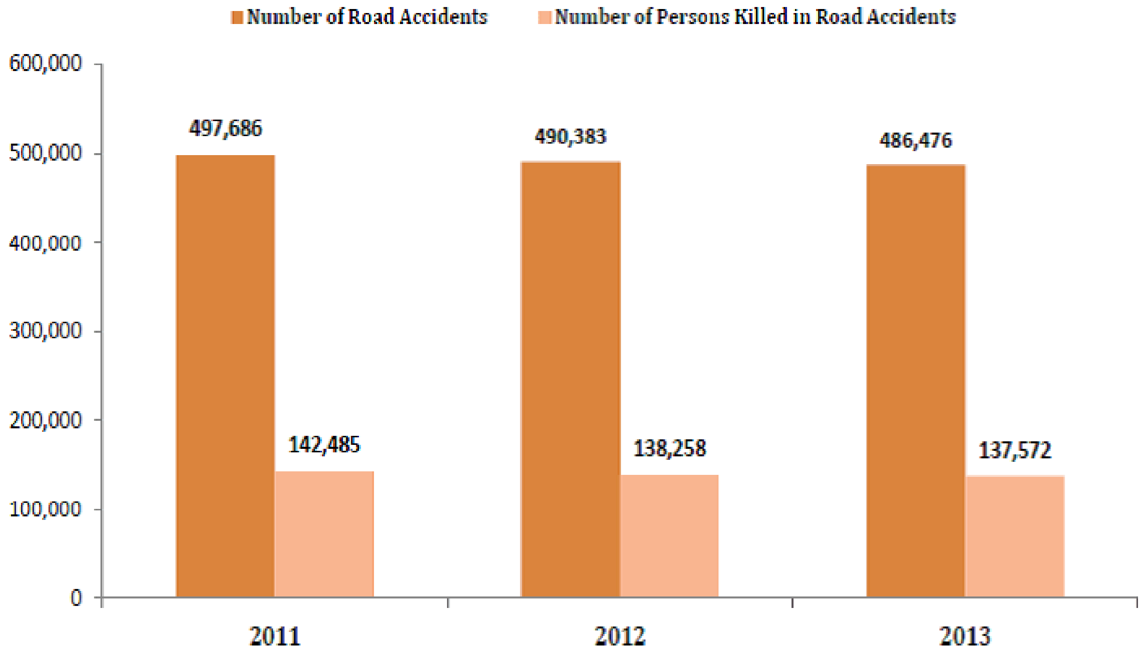

Figure 1.1. Number-of-Road-accidents-Deaths-2011-2013

1.3. STRUCTURE OF PROJECT

The report is divided into 4 sections i.e., Introduction, Literature Review, Description of Model and Transportation of Precast Segment. The Literature Review section contains the details regarding Traffic Management Plan. The Description of Model Section contains the design and the detail process how the diversion plan is processed to prevent the road accidents and by which the transportation of Precast segment can be done from the stacking point to the point of erection with an objective to minimize or alleviate disruptions to existing travel pattern and other activities while re-organizing through / regional movements and implementing temporary measures in the influence zone of the project area at the instance of Delhi Metro Rail Corporation (DMRC) for construction work at Construction of viaduct from P11-18 to P11-26 of CC-77 – Construction of viaduct and Stations for YMCA-Ballabhgarh Extension of Dehli

MRTS Phase-III. . The Transportation of Precast Segment section explains the methodology of transportation of precast segment from the stacking point to the erection point.

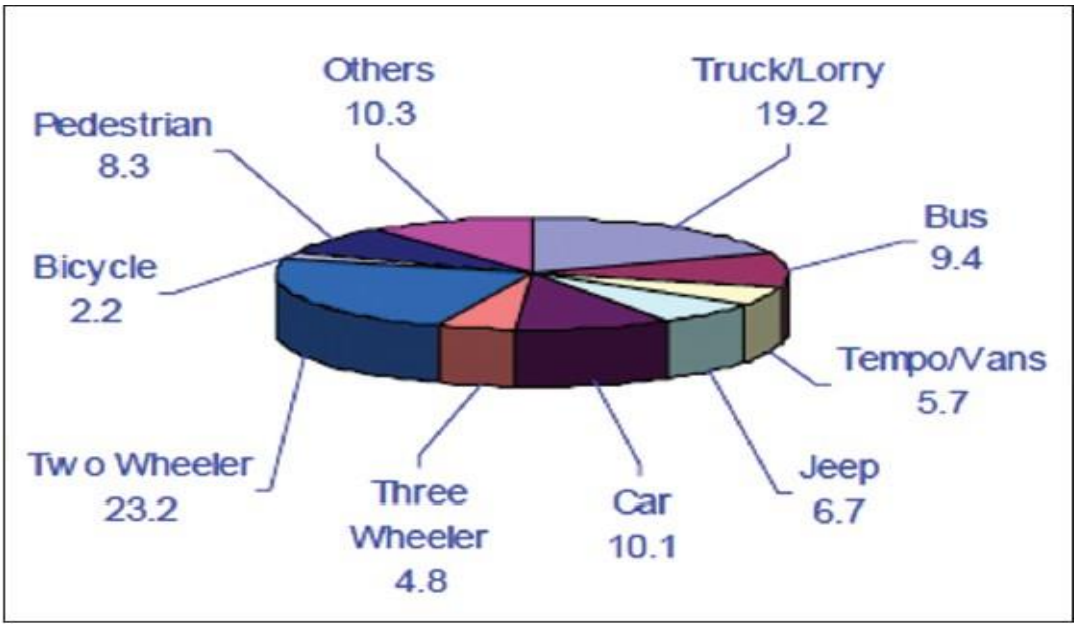

Figure 1.2. Accident Exposure

1.4. INTRODUCTION TO THE PROJECT SITE

Larsen & Toubro Limited is listed as one of the largest and most respected companies in India's private sector. With over 75 years of a sturdy, customer focused method and a continuous quest for world-class quality, L&T has supreme capabilities across Technology, Engineering, Construction and Manufacturing, and preserves a leadership in all its major lines of business. Its large technology base and pool of experienced workforces enable it to be a system integrator in rail infrastructure and rail transit systems, bringing multi-disciplinary rail projects from concept to commissioning.

L&T has contributed meaningfully to the successful implementation of Phase I and Phase II of the Delhi Metro Rail Corporation Project. At present L&T is working on Phase III of Delhi Metro Rail Corporation Project.

1.4.1. LOCATION

The Delhi Metro Corridor extends North to South from YMCA to Ballabhgarh over a distance of 3.483 km including 2 stations NCB station and Ballabhgarh Station of 140m each for standard gauge twin metro rail.

The Metro is elevated line along the centre line of the existing road corridors of Delhi Mathura Road. The width of right way is variable throughout the corridor from 32m to less than 16m.

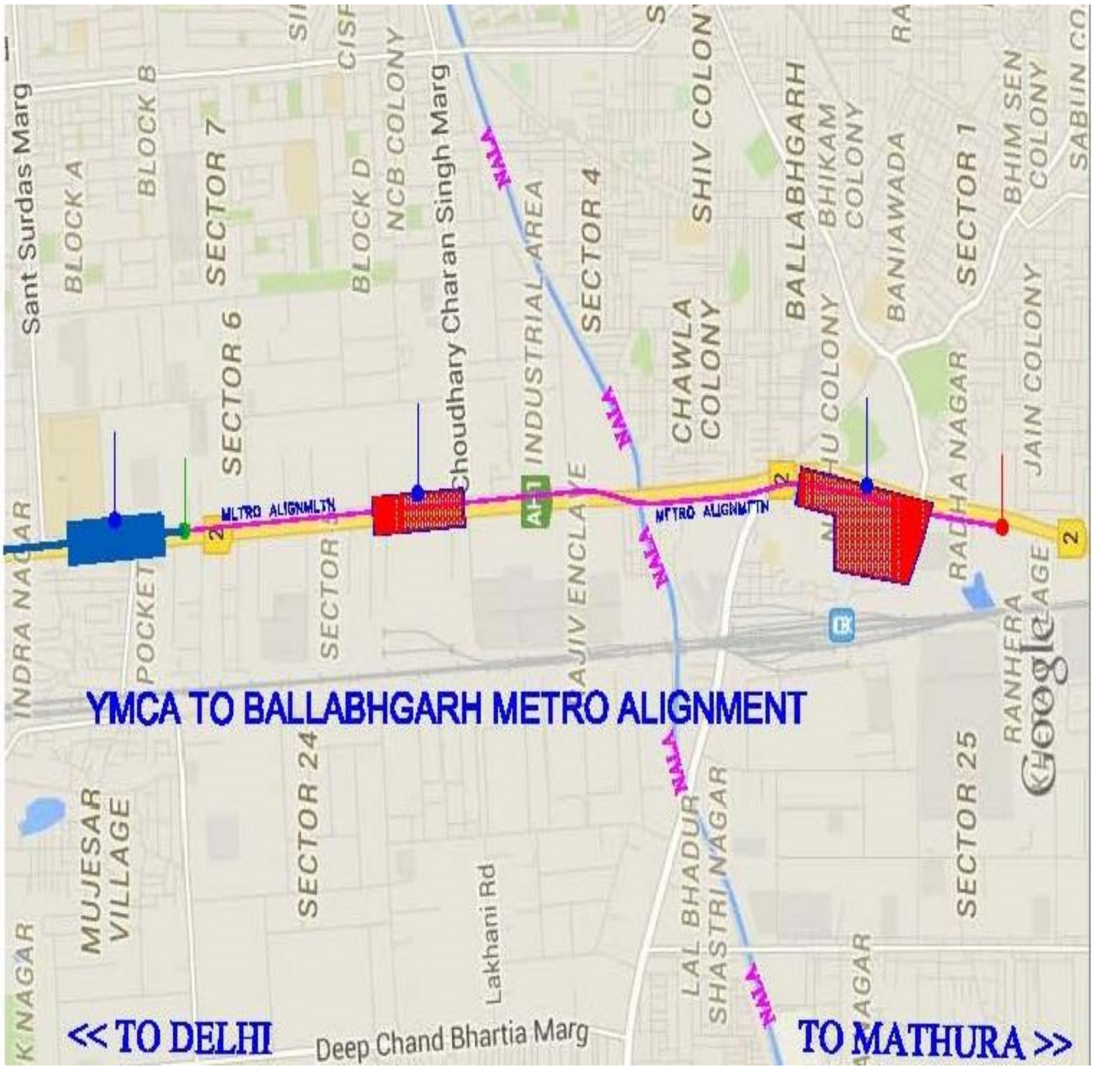

Figure 1.3. YMCA to Ballabhgarh Metro rail line map

1.5. PURPOSE OF DIVERSION PLAN

Due to swift growth in economic, industrial, and commercial activities, there has been a giant increase in the traffic working on the city roads. The traffic crusade is majorly towards Delhi and Faridabad.

NH2 is a four lane carriageway, linking Delhi with Agra, further the project is widening to six lanes by NHAI. Once complete, the project is anticipated to significantly recover the traffic movement along NH2.

But alongside the NH2, the elevated Metro rail is being constructed from Badarpur Border to Ballabhgarh. The Delhi Metro corridor extending from Badarpur to YMCA has already finished during Phase II of the Delhi Metro Rail Corporation Project.

The Diversion Plan is a (normally temporary)design or planning where a special route is arranged for the traffic to follow when the normal route cannot be used or we can say as a plan which makes the route taking traffic around an area of prohibited or reduced access.

CHAPTER 2

LITERATURE REVIEW

2.1. TRAFFIC MANAGEMENT

The basic impartial of the following guidelines is to put down procedures to be espoused to ensure the safe and efficient movement of traffic and also to safeguard the safety of workmen at construction sites. All construction workers should be afforded with high visibility jackets with reflective tapes as supreme of viaduct /tunnelling and station works or either overhead or beneath right-of way. The conspicuousness of workmen at all times shall be augmented so as to shield from speeding vehicular traffic.

The guiding principles to be espoused for safety in construction zone are as follows:

i) Warn the road user evidently and sufficiently in advance.

ii) Provide safe and clearly marked lanes for managing road users.

iii) Provide safe and clearly manifested buffer and work zones

iv) Provide adequate measures that govern driver behaviour through construction zones.

2.2. COMPONENTS OF ROAD CONSTRUCTION ZONE

2.2.1. TRAFFIC CONTROL ZONE

Traffic Control zone shall be divided into the following three components,

- Advance Warning Zone
- Transition Zone
- Working Zone

2.2.2. ADVANCE WARNING ZONE

The "advance warning zone", shall

- provide and inform the road users about the, Presence of the hazard through suitable sign with distance to the hazard;
- Changes disturbing traffic arrangements (such as a decline in the number of lanes and/or in the speed limit) within the traffic control zone.
- Extent and type of hazard.

2.2.3. APPROACH TRANSITION ZONE

Approach transition zone shall,

- Guide the traffic into the altered traffic flow pattern around the working zone.
- Reduce the approach speed of the vehicles and channelize them into the narrower and for restricted number of lanes or a temporary carriageway.

2.2.4. WORKING ZONE

Working zone shall,

- Have adequate lateral and longitudinal buffer zones.
- Continue to control speed of the plying vehicles should
- Shall delineate to avoid vehicle intrusion in the working area.

2.2.5. TERMINAL TRANSITION ZONE

The terminal transition shall,

- Have sufficient space to allow traffic into normal lanes
- Extend from the downstream end of the working area and have the sign to indicate the end of works.

2.2.6. LONGITUDINAL BUFFER ZONE

This zone shall have adequate space between the end of the lead-in taper of cones (T) and the working space to avoid intrusion of traffic into the working zone.

2.2.7. LATERAL BUFFER ZONE

This zone shall have sufficient width between the working space and the moving traffic.

2.2.8. SAFETY ZONE

Safety zone shall,

- Consist of Approach Transition Zone, Terminal Transition Zone, Longitudinal buffer zone & Lateral buffer zone.
- Protect workmen from the traffic and to protect the traffic from them.
- Not have materials and equipment

- Allow workmen only to enter the zone to maintain cones and other road signs.

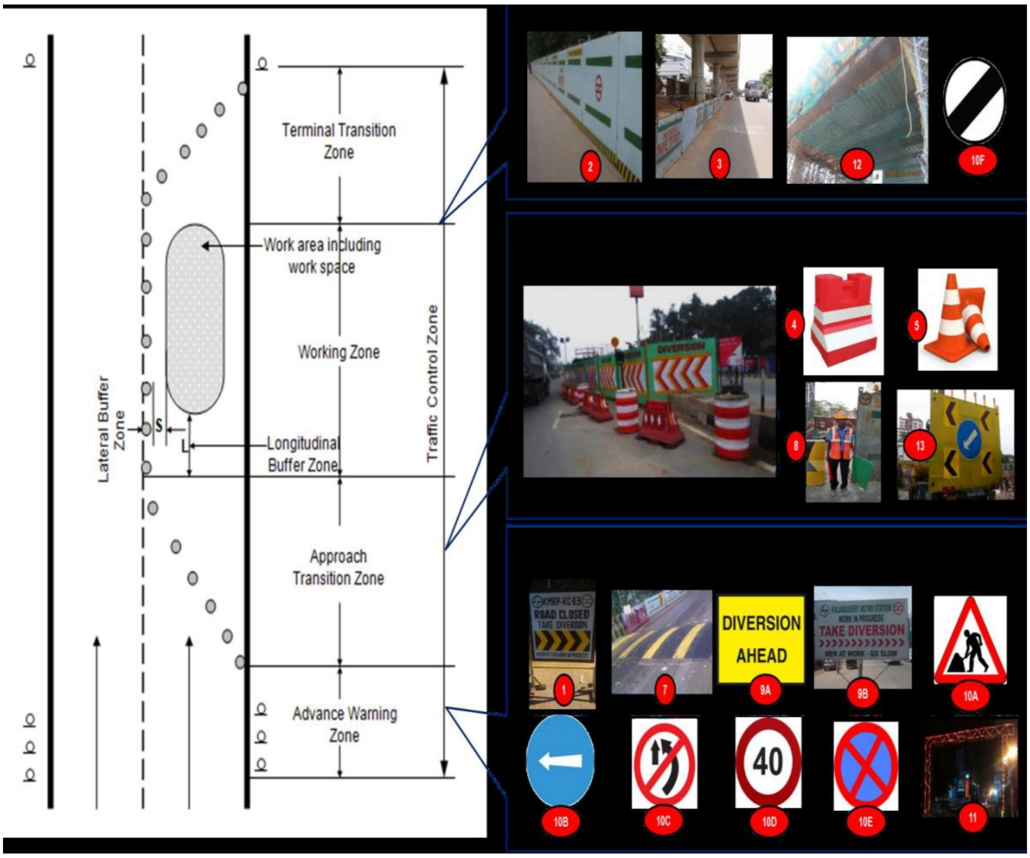

Figure 2.1. Components of Construction Zone

2.3. LEGAL PERMISSION

In all cases, the contractor shall ensure proper precautions. Wherever operations undertaken are probable to interfere with public traffic, specific traffic management plans shall be haggard up and executed by the contractor in consultation with the sanction of local police authorities and/or the anxious metropolitan/civil authorities as the case may be.

Such traffic management plans shall comprise provision for traffic diversion and selection of the alternative routes for transport of equipment. If essential, the contractor shall carry out road widening before beginning of works to accommodate the extra load. The primary traffic control devices castoff in work zones shall include cones, signs, delineators, pylons, pavement markings, barricades, and flashing lights.

The road construction and maintenance signs which plunge into the same three major classes as do other traffic signs, that are Regulatory Signs, Warning Signs and Direction (or guidelines) Signs shall only be used.

2.4. TRAFFIC CONTROL DEVICES

2.4.1. REQUIREMENTS OF TRAFFIC CONTROL DEVICES

- Be proficient of being understood easily and carry only one meaning.
- Be indoors the cone of vision of the driver and be sited such that it allows adequate response time at average speed.
- Be able to repel the local wind pressure, rain and vibrations but not be a rigid obstacle in the event of collision.
- Providing sufficient events that control driver behaviour through construction zones.
- Be installed for the minimum required time and be removed immediately to avoid hindrance to traffic
- Be serviced and maintained regularly

The primary traffic control devices shall be placed in Road construction as per the requirement:

a. Road Signs
b. Delineators
c. Barricades
d. Cones
e. Flashing lights etc.

2.5. ROAD SIGNS

2.5.1. CLASSIFICATION

Road signs classified into the following three major categories shall be provided in the road construction zone

- Mandatory / Regulatory Signs
- Cautionary / Warning Signs.
- Informatory Signs

Apart from the above three major categories, a special category named "Work Zone Signs" shall also be provided to guide traffic through highway construction / maintenance zone.

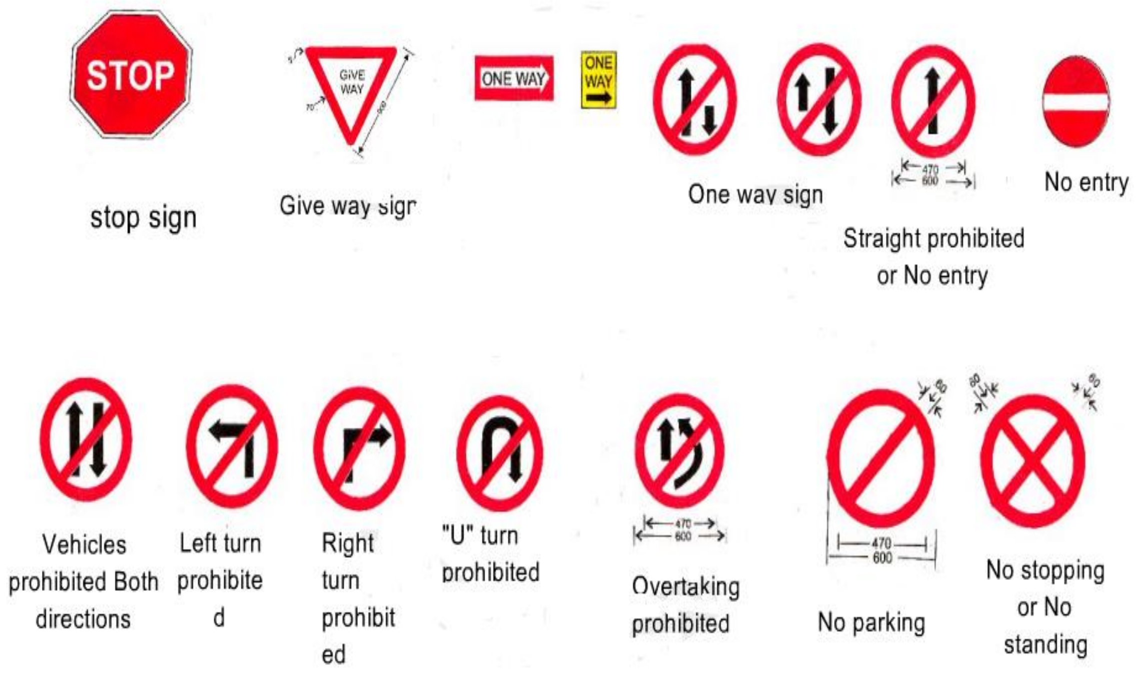

Figure 2.2. Road Signs

2.5.2. REQUIREMENTS OF ROAD SIGNS

Road Signs shall,

- Be well located so that its message is clearly visible.
- Be of period reflective of high intensity grade or engineering grade.

2.5.3. REGULATORY SIGNS

Regulatory signs enforce

- Legal restriction on entire traffic and violation of these shall be an offence.
- Be mostly circular in shape.

It is crucial therefore, that they are used only after consulting the local police and the traffic authorities.

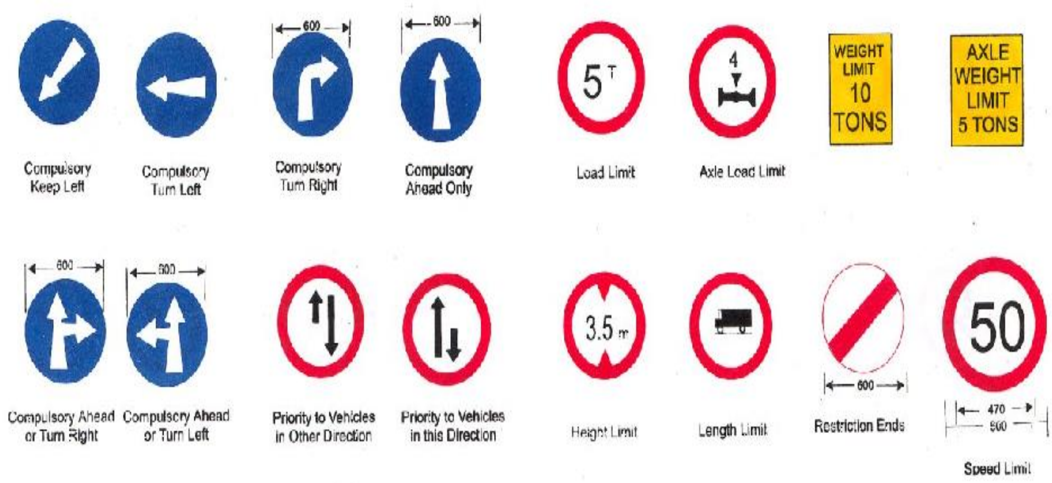

Figure 2.3. Regulatory Signs

2.5.4. WARNING SIGNS

In the traffic control zone Warning signs shall be utilised to counsel the drivers of specific hazards that may be encountered. The contractor shall place diversion signage at strategic locations and set up appropriate warning signs. In order to reduce disruption of right of entry to residences and business, the contractor shall uphold at least one entrance to a property where multiple entrances exist. A warning sign as given in general instruction shall be installed at all secondary road which come together with the primary road where the construction work is in growth at sufficient distance before it fuses with the primary road so as to alert the road users about the 'Metro Work in Progress'. Materials hanging over / protruded from the chassis / body of any vehicle especially during the work of material handling shall be indicated by red indicator (red light/flag) which indicates the caution to the road users.

Figure 2.4. Warning Signs

2.5.5. INFORMATORY SIGNS

Informatory signs shall

- Be used to guide road users along the routes, enlighten their about destination and distance, and also to identify point of geographical and historical interest.
- Provide other info that will make the road users to travel easier, safe and pleasant.
- Be generally rectangular in shape.

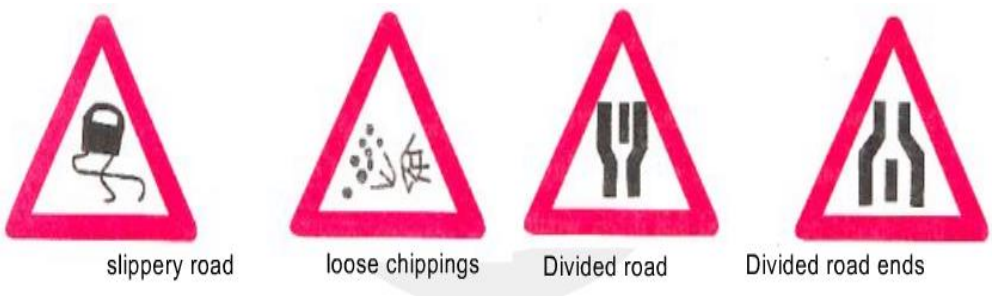

Figure 2.5. Informatory Signs

2.6. DELINEATORS

The delineators are the rudiments of a total system of traffic control and have two discrete purposes:

i) To delineate the drivers and guide them to and along a safe path

ii) As a taper guiding to move traffic from one lane to another lane.

These channelizing contraptions such as cones, traffic cylinders, tapes and drums shall be sited in or adjacent to the roadway to control the flow of traffic. These should generally be retro-reflectors complying to IRC: 79 - Recommended Practice for Road Delineators.

2.6.1. TRAFFIC CONES AND CYLINDERS

Traffic cones measuring about 500mm, 750mm and 1000mm high and 300mm to 500mm in diameter or in square shape at base and are frequently made of plastic or rubber and generally have retro-reflectorized red and white band shall be used wherever necessary.

Figure 2.6. Safety Cones

2.6.2. DRUMS

Drums measuring about 800mm to 1000mm high and 300mm in diameter can be used either as channelizing or warning devices. These are highly noticeable, give the appearance of being daunting objects and therefore command the respect of drivers.

2.6.3. BARRICADES

Full height fence, barriers, barricades etc. shall be erected around the site in order to avert the working area from the risk of accidents due to prompt vehicular movement. Same the way barricades guard the road users from the danger owing to construction equipment and other temporary structures. The structure dimension of the barricade, its colour scheme, material and composition, DMRC logo and other details shall be in accordance with specifications placed down in tender document. All barricades shall be erected as per the design necessity of the Employer, numbered, painted and preserved in good condition and likewise barricade in-charge upholds a barricade register in site. All barricades shall be clearly seen in the dark/night time by the road users so that no vehicle hits the barricade. Conspicuity shall be safeguarded by affixing retro reflective stripes of required shape and size at appropriate angle at the bottom and middle portion of the barricade at a minimum gap of 1000mm. In addition to it, minimum one red light or red light blinker should be sited at the top of each barricade.

Barricades shall afford containment without significant deflection or deformation under efect and to redirect errant vehicles along the barrier.

Barricades can be used as follows:

- Prevent traffic from entering into the work areas, such as excavation, material storage area.
- Provide shield to workers.
- Discrete two-way traffic.
- Protect construction such as deceptive work for culverts and other exposed objects.

Barricades can be permanent or movable. Portable barricades should be stable under adversative weather conditions and seem substantial but not so much as to cause undue damage if a vehicle strikes.

The three types of typical barricades generally used to avoid road accidents in road construction zones shall conform to the data given in the following table:

Table 2.1. Types of Typical Barricades

Type	Type-I	Type-II	Type-III
Width of rail	200 — 300 mm	200-300mm	200-300mm
Length of Rail	2 m — 2.5 m	1m-1.2m	2m-3m
Width of Strip	200 mm	200mm	200mm
Type of Frame	Heavy "A"	Frame Light "A"	Frame fixed, Demountable
Flexibility	Essentially	Portable	Essentially Permanent

2.6.3.1. Type I and Type II Barricade

These barricades shall be:

- used when traffic is redirected in a road.

- used interchangeably
- more appropriate for repair, maintenance and other temporary works.
- Have stability against wind and the stability shall be improved through ballast.

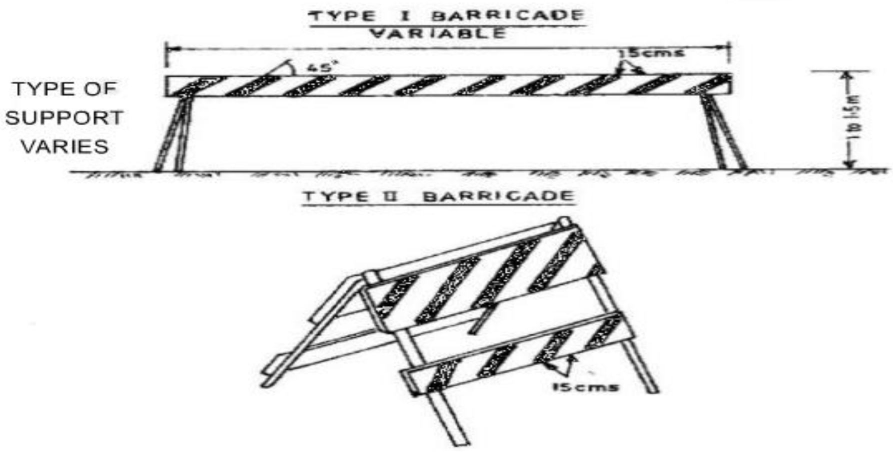

Figure 2.7. Type I and Type II Barricade

2.6.3.2. TYPE III BARRICADE

These type of barricade shall,

- Be of enduring and be erected at the point of closure when a road section is closed to traffic for construction works.
- extend completely across a road way and its shoulders or from wayside to wayside with a small gate or movable section for the entrane of construction workmen and vehicle.

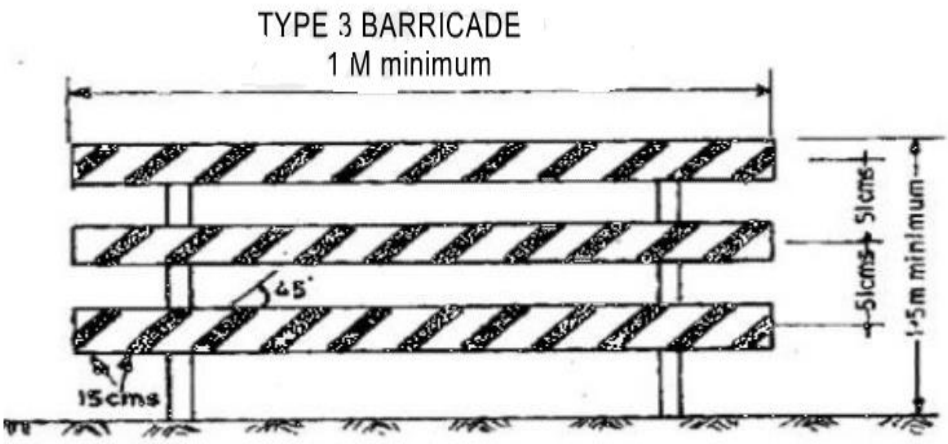

Figure 2.8. Type III Barricade

2.6.4. FLAGMEN

Control of traffic through work area in a road construction zone shall be done by a flagmen where ever found necessary. Flagmen should be armed with hand signaling devices such as flags and sign paddles. The flag and Paddle shall obey to the following specifications given below:

Flagmen need to uphold the flow of traffic continuous past a work zone at comparatively abridged speeds by suitably amendable the traffic. He shall sojourn the traffic for a squat while whenever mandatory (e.g. for entry and exit of construction equipment in to work zone). Flagman shall be sited in a place where he is clearly perceptible to approaching traffic and at a sufficient distance to aware the drivers to respond for his flagging instructions.

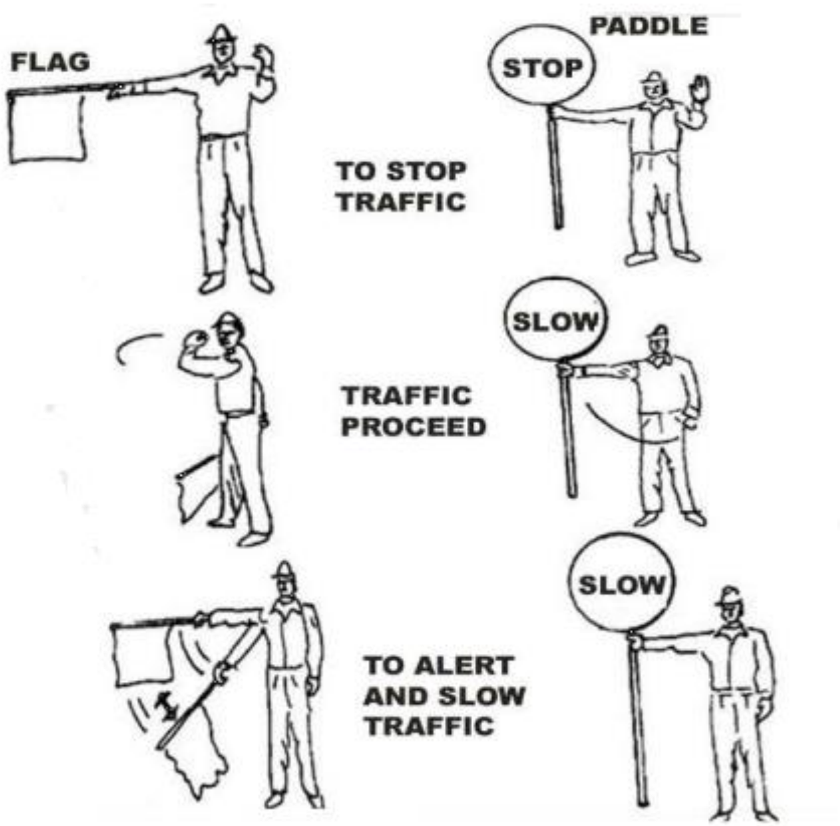

Figure 2.9. Flagmen

CHAPTER 3
DESCRIPTION
OF
MODEL

3.1. PURPOSE

Traffic Diversion Plan (TDP) is prepared at the instance of Delhi Metro Rail Corporation (DMRC) for construction work at Construction of viaduct from P11-18 to P11-26 of CC-77 – Construction of viaduct and Stations for YMCA-Ballabhgarh Extension of Dehli MRTS Phase-III.

This TDP has been designed with an objective to minimize or alleviate disruptions to existing travel pattern and other activities while re-organizing through / regional movements and implementing temporary measures in the influence zone of the project area.

3.2. SCOPE

Our interpretation of scope of work of this TDP during construction is as follows:
Approach for the Traffic Management Plan to include improvement of intersections, relocation of bus stops, parking restrictions, lane widening, traffic signage schemes etc.

- Road re-engineering and traffic diversion scheme during construction.
- Traffic schemes all along alignment including blockage of service roads, widening of service roads, shifting of bus stops, relocating traffic signal posts etc. during construction to ensure smooth operation of construction activities and flow of traffic.
- Detailed plans at each station location, size, specification and number of sign boards required for traffic safety/smooth traffic movement and smooth operation of construction activities.
- Interacting with local authorities like PWD, MCD, Railways, Traffic Police, etc. for firming up the Traffic Management Plans, Diversion Schemes, rerouting of traffic etc. and getting their approval including making any presentation etc.

3.3. PLAN

In order to examine the issues and concerns related to traffic circulation, accessibility of surrounding land uses and on-street car parking throughout the project during construction of the MRTS, I analyzed a detailed reconnaissance survey along the study of available carriageway configuration which has been undertaken. Based on site potentials and limitations, environmental considerations, traffic and parking, a feasible

Traffic Diversion Plan has been designed to facilitate MRTS construction and traffic requirements to an optimum level to the extent possible.
Barricading / Diversion Plan maintaining minimum 9 m wide construction zone as per keeping centrally the proposed MRTS alignment during the construction has been planned protecting the following features to the extent possible:

- Overhead and underground services etc.
- Footpaths
- Service roads.
- Pedestrian movement

3.3.1. AREA BARRICADING

Phase I - The working location at PP11 20 comes on the road so the traffic diversion will be started from P11-19. CP11-21 is located on road to Agra and PP11-25 is located on road towards Delhi (Ref. Figure No 13). For smooth diversion of traffic working area will be barricaded with full size barricading boards. There will be only one entry point at CP11 21 for the entry and exit of construction vehicles. This entry will be provided with gate to prevent unnecessary entry. Single entry & exit will reduce the traffic disturbance caused during vehicle maneuvering.

The pink line in the middle indicates the median of the road and the blue shaded portion shows the barricading portion in both sides. The distance from the barricading board to the median of the road is 10 m at P 11-21 and 10.2m at P11-24 in the road approaching towards Agra.

Phase-II In this phase the total area will be barricaded including from P11-22 to P 11-25(Ref. Figure No 14). For smooth diversion of traffic working area will be barricaded with full size barricading boards. There will be only one entry point at the median of the adjacent to the CP11 21 for the entry and exit of construction vehicles. This entry will be provided with gate to prevent unnecessary entry. Single entry & exit will reduce the traffic disturbance caused during vehicle maneuvering.

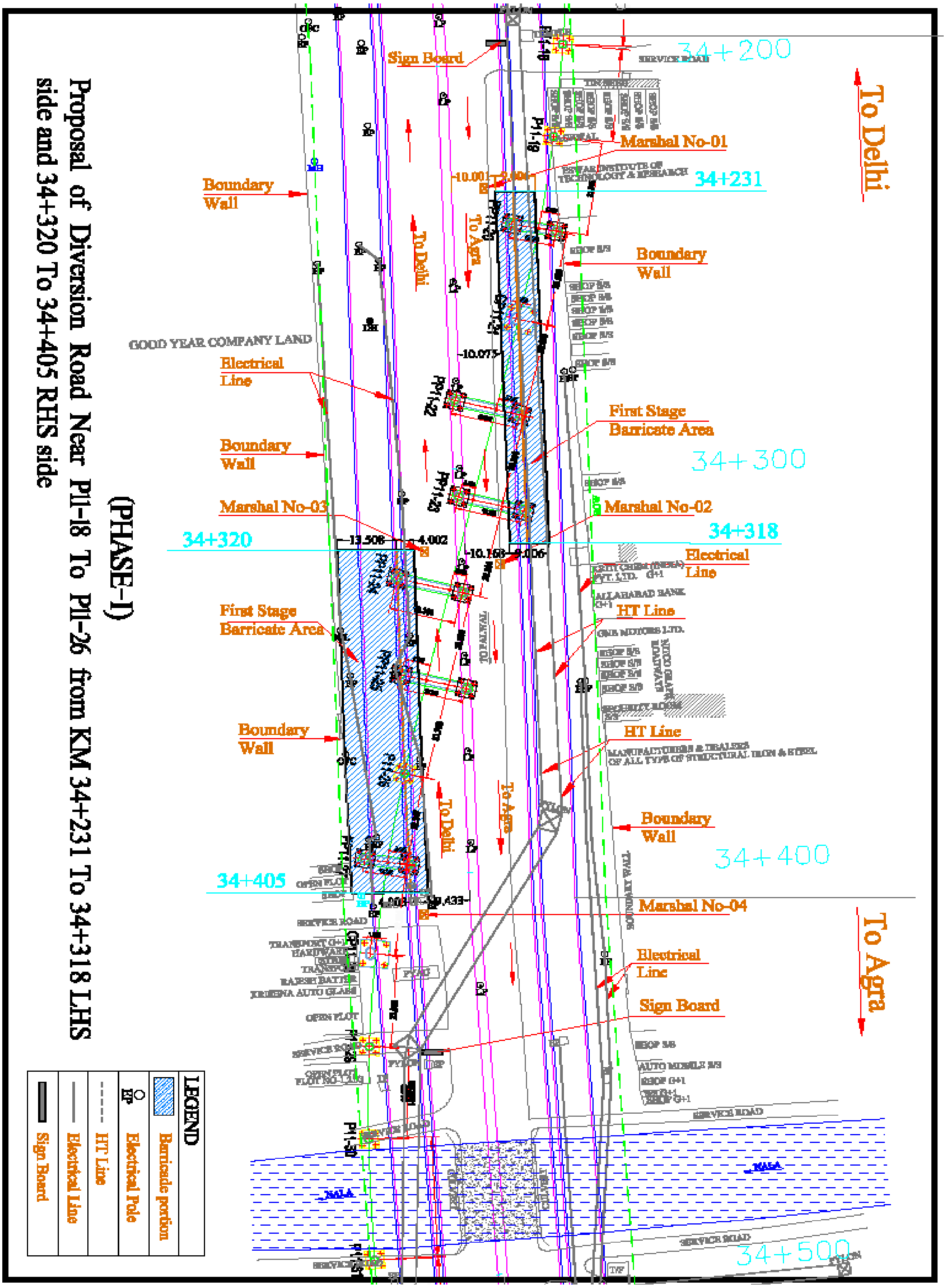

Figure.3.1 Phase I Diversion Plan

3.3.2. REFLECTORS

Reflectors will be installed on barricading boards in chevron pattern especially in the entry side of traffic. Apart from this arrows and direction marks will be fixed as reflectors. On the top of barricading boards, triangular reflectors will be installed for better reflection. Road stud (Cats eye) to be fixed along with barricading boards for better alignment visibility on road.

3.3.3. PEDESTRIANS WALKWAY

Pedestrian’s walkway will be identified and marked properly for common use. Bilingual display signboard will be installed for information. The pedestrian’s walkway will be provided with handrail to isolate pedestrians from upcoming traffic.

3.3.4. TRAFFIC MARSHALLS

Total 06 Nos. of traffic marshals will be deployed 3 in each side of barricading area for smooth direction of traffic. Main function of traffic marshal is to direct the traffic and guide the construction vehicles. The traffic marshals have duty to help pedestrians to cross the road as and when required.

3.3.5. IMPACT PROTECTION MEASURES

Concrete blocks are placed behind barricading boards and diversion area for impact protection.

3.3.6. SIGN BOARDS

Sign boards will be installed in work space , traffic space and buffer space as per IRC:SP:55,4.2.2.

3.4. ADDITIONAL CONTROL MEASURES

3.4.1. SAFETY MEASURES TAKEN BY TRAFFIC MARSHAL:

3.4.1.1. TRAFFIC BATONS

The marshal use traffic batons by which he can direct traffic to slow down the speed of traffic in a temporary traffic control zone.

3.4.1.2. FLAGS

It can uphold the movement of traffic continuous past a work zone at comparatively reduced speed by suitably controlling the traffic in day time.

3.4.1.3. HIGH VISIBILITY VEST

The Marshal should wear fluorescent vest retro reflective strips which can be easily discernible from any background to prevent any accident by vehicles. Wearing high visibility vest is mandatory in night shift.

3.4.1.4. WATER FILLED BARRIERS

Water filled PVC barriers will be provided near the barricading board to provide protection from the incoming traffic.

3.4.1.5. REFLECTORS ON BARRICADES

Reflective tapes and reflectors shall be provided with barricading boards to provide caution for ongoing traffic . Along with reflectors rope lights will be provided to indicate the alignment of barricading boards.

3.4.1.6. AREA LIGHTING

Temporary traffic control activities frequently create conditions on or near to the travelled way that are particularly unforseen at night, when drivers, visibility is abruptly reduced. It is frequently desirable and necessary to complement retro reflectorized signs, barriers, and channelizing devices including lighting devices which will be extant on equipment crossing and rest other areas where existing light is not suitable for the work to be performed safely.

Adequate area lighting will be ensured at entry exit points for better visibility.

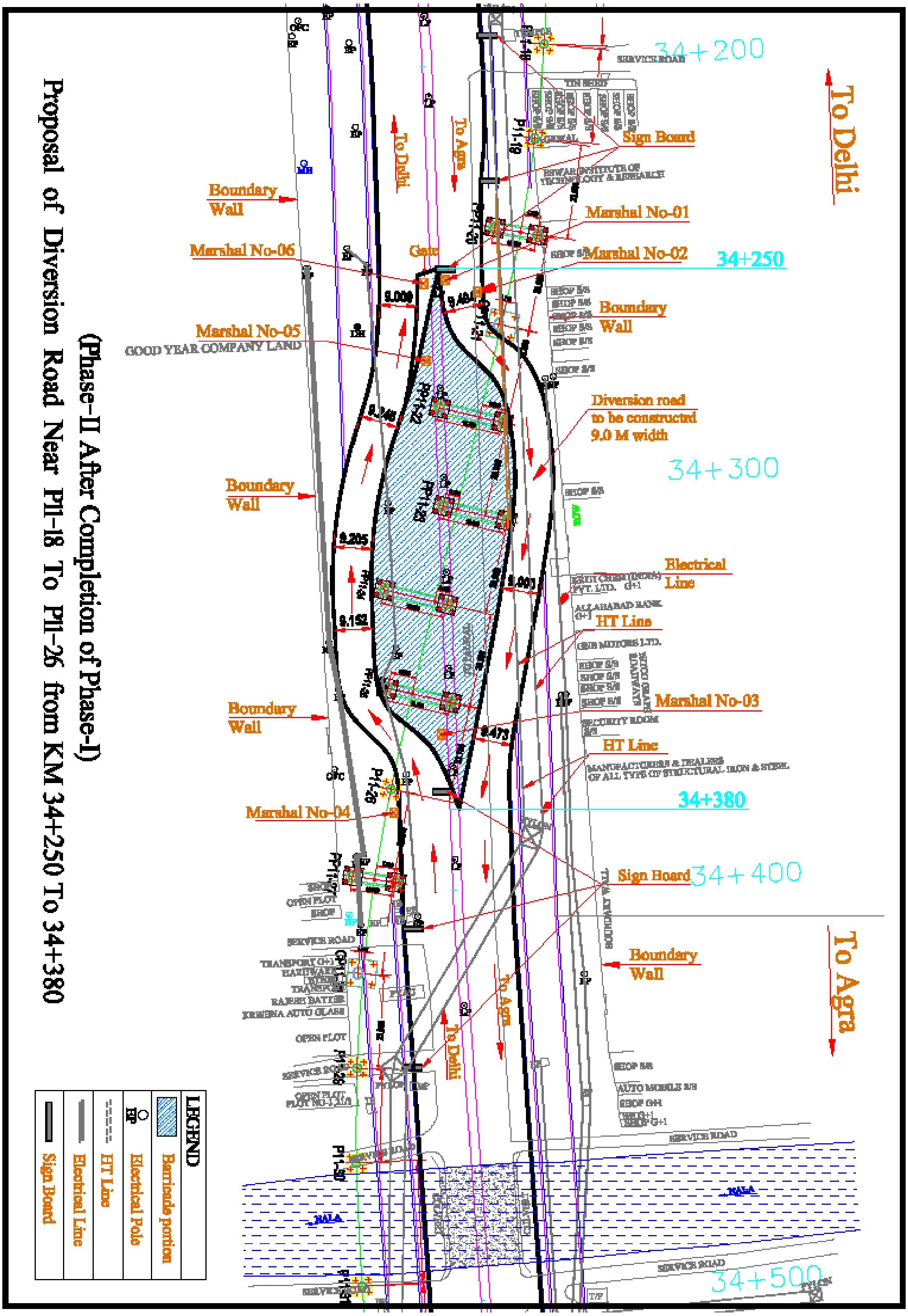

Figure.3.2. Phase II Diversion Plan

CHAPTER 4

IMPLEMENTATION

The Phase I diversion has been submitted to my company which was further checked by the client DMRC and the local authority and the phase I is now implemented at Delhi metro corridor i.e., from via duct P11-20 to P11-26.

At present the phase-I construction is under process and the excavation work is going on which will be followed by Pilling construction.

This Phase –I diversion is estimated to get completed within the 1st week of February 2016. After the completion of phase-I diversion it will be followed by Phase-II diversion on the second week of January 2016.

Figure 4.1. Excavation at the road side at P11-24 to P11-27 way to Delhi

The diversion plan it became easy for the road users and to reduce the flow of dense traffic. The diversion plan proposes the safe movement of hauling and hoisting vehicles used in the site. After the fully completion of both the Phases the transportation of precast segment will start.

Figure 4.2. Excavation at the road side at P11-20 to P11-23 way to Agra

Transportation of Precast segment include Pier cap, I-Girders and U-Girders. Pre-cast, pre-stressed Pier cap, I-Girders and U-Girders are proposed by DMRC for normal spans of elevated viaduct between Badarpur – Faridabad under DMRC’s contract CC-77. After the completion of diversion the transportation procedure will come into access.

CHAPTER 5

TRANSPORTATION OF PRECAST SEGMENT

5.1. PREAMBLE

Pre-cast, pre-stressed Precast Segments is proposed by DMRC for normal spans of elevated viaduct between Badarpur – Faridabad under DMRC's contract CC-77 at locations where wider cross-section is required especially to accommodate cross-over or ramp for moving rolling stock to maintenance yard. Detailed Method Statement for Transportation of this Precast Segment is given below.

5.2. EQUIPMENTS:

Outline of the equipment's to be deployed for the transportation of Precast Segments is listed below:

1. Gantry cranes of 100 MT
2. 1 no's (with minimum capacity 200 MT) Crane for Erection
3. Heavy Duty Multi Axle Trailer(Capacity not less than 70 MT, Drawing enclosed)
4. Lifting Devices and other tools & tackles
5. Survey Instruments – Total Station, Auto Level, etc.
6. Vibratory Roller – 11 Ton capacity
7. Strong back (lifting beam).
8. JCB.
9. DUMPER.

5.3. TRANSPORTATION FROM STACKING LOCATIONS TO ERECTION POINT

The Precast Segments, casted as per approved drawing, shall be transported from the stacking yard to the erection points by means of Multi Axle trailers as per the following sequence of operations,

1. The route of transportation shall be pre-decided and all approvals from the concerned authorities' field erection team shall be taken prior to the transportation of Precast Segments from precast yard up to the erection locations.
2. Trailers and Lifting Devices (Cranes & Tackles etc.) shall be inspected each time before loading.
3. The survey axis on both faces of Precast Segments shall be marked and assembly unit as per erection scheme will be fitted with Precast Segments.
4. The Precast Segments shall be loaded on the multi axle trailers by means of Gantries in the Stacking Yard as per the lifting provisions.

5. The loading will be done on the fabricated frame fixed with trailer and shall be secured in position properly; the lashing arrangements shall be checked by transportation supervisor.

Figure 5.1. Loading of Pier Cap in Multi axle trailers

Note:

- *Rubber/wooden plank will be provided below I-Girder support location to absorb vibration from vertical movement due to poor road condition.*

6. The transportation of the Precast Segments will commence only after getting confirmation from erection location that the site is ready for erection.

Note:

- *The Span lengths for U-Girder vary from 15.00 to 27.00 m.*

7. During transportation on public roads, each trailer shall be accompanied by escort vehicle at both ends with red flags (flasher for night) along the entire length of travel. The entire movement shall be escorted by traffic marshals.

Figure 5.2. Transportation of U-girder Movement escorted by Traffic Marshal

Figure 5.3. Multi axle trailers for I-girder transportation

CHAPTER 6

CONCLUSION

The Diversion plan for the Delhi Metro Corridor extending from North to South from YMCA to Ballabhgarh over a distance of 3.483 km including 2 stations NCB station and Ballabhgarh Station of 140m each for standard gauge twin metro rail has been successfully implemented at the site resulting ease for the roads user to travel along the Delhi Agra road.

The Phase I diversion is implemented at the site with all safety guidelines required for the road users and the expected completion for the same is by the month of January 2016 and it will be followed up by Diversion plan Phase II which peruse more safety measures than the Phase I. Safety Measures will be daily followed up during the diversion plan. Safety Marshals play a major role in diverting the road users and as observed by me there has been no such evolvement of road hazard after the diversion.

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Reference

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3. Impacts Of Roadway Condition, Traffic And Manmade Features On Road Safety, Achuta Nanda, 2013
4. International Transport Forum (2008). "Towards Zero, Ambitious Road Safety Targets and the Safe System Approach". OECD. Retrieved 26 January 2012. It recognises that prevention efforts notwithstanding, road users will remain fallible and crashes will occur.
5. IRC: SP: 55 - 2001 - Guidelines on Safety in Road Construction Zones.
6. IRC: 67 - 1977 – Code of Practice for Road Signs.
7. IRC: 79 - 1981 - Recommended Practice for Road Delineators.
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9. IRC: SP: 44-1996 - Highway Safety Code.

SECTION 2

CHAPTER 7

INTRODUCTION

7.1. GENERAL

Safe working and prevention of the accidents is the main aim of the construction industry. Work-related illnesses and injuries, including fatalities, in construction occur at a rate that is 54% higher than the rate for all industries, making it one of the most hazardous occupations. The comparative result and the safety performance for the past few year accidents can be helpful to minimize the accident scenario. Hence we require some techniques for determining the safety measures and to provide safety performance measuring rating for the construction industry. By the use of this technique we can find out the weakness in implementation of safety program in the industry so that we can further build a sturdy safety system. This report is based on the quantitative measure for the past few year accident result of the industry so as to evaluate the safety rating and performance for the better understanding of the progress of safety culture in the industry. This process can contribute to a positive progression in the organisation comprising a higher entity of participation and sharing of information. Safety culture is slice of organizational culture and it tends to emphasis on deeper and less willingly accessible core standards and assumptions of the organization on the basis of safety and human resources. Comparing an industry which is committed for strong safety culture with the industry which is not consistent in following the ideal safety system helps us to find out the flaws in implementation of safety program and reduce the number of accidents. It is widely accepted to pay attention by companies as well as by safety authorities that to work safely, reliably and effectively necessitates a management attention at all organizational levels, and also effective and efficient tools to be used by managers. This thesis work can help the construction industries to examine their safety performance and to progress the safety culture in their organisation.

7.2. PURPOSE OF PROJECT

The main prospective of this research work is to consider quantitative monitoring of accidents in construction industries for the past few years (2011-16). Accidental report may be produced as a significant feedback tool to inspect safety performance. Accidental report are routinely expressed as rates, per unit community or for every period worked. Calculation of duties necessitates numeral sum of hurts and exposures. Frequency rates describe injuries in terms of hours of disclosure taking into account evident exposure to the risk. Severity rates describe the numeral sum of days omitted in time limit of exposure, considering the depth of the hurt caused. Incidence duties count physical hurts in terms of sum of persons subjected to hazard every year. Rates can either be proposed for employees or for workers in comparison to statistics of fatalities and genuine injuries which afford more stable indices of safety performance.

This work focuses on safety attitude monitoring or rating. The main objective is to allow a platform for argumentation on the safety performance rating of construction industries with an approach on the limited report available. In this thesis I have taken accident details data from two specific construction industries so as to analyse the safety performance rating and developed a safety culture questionnaire which is answered by members of both industries so as to scrutinize the safety climate within the organization to confront out the flaws in implementation of safety system and minimize the number of accidents. The Safety Culture Questionnaire has in this thesis work been developed and offered as a tool which construction industries can use to analyse and improve safety culture. The questionnaire is prepared to reflect challenges that the construction industry is confronted with. These challenges were disposed through the interaction with the members of the organisation and are related to four main regions:

(1) Administration, management, responsibility and assets,

(2) Individuals and the groups at the interfaces,

(3) Collaboration across interfaces,

(4) Learning processes.

The edifice of the questionnaire helps being a safety culture ladder to the organisation in which it can climb, and for each question there are descriptions for three of the five safety cultural levels.

The aim of this questionnaire; which is especially developed and specified to reflect the challenges the construction industries is to analyse the progressing scenario of safety culture so that it will helpful to appraise the safety performance and improve the safety climate in the construction industries.

7.3. SAFETY TERMINOLOGY

- **Accident**

  Accident is defined as the dangerous occurrence following into injury to the worker or vandalism to the property. An accident is an unenviable incidental and unplanned event that could have been intercepted had circumstances leading up to the accident been acknowledged, and acted upon, antecedent to its occurrence. Most scientists those who study unintentional injury avoid using the word "accident" and focus on factors that gives increment to risk of severe injury and that lower injury incidence and severity.

- **Death**

  Fatality resulting from an accident.

- **Injury**

  An injury can be defined as an external damage caused to the human body.

- **Loss Time Accident**

  LTA is an accident which extends beyond the day of the shift.

- **Disabling injury**

  Any injury (single or multiple) to a person which is caused out of his employment (personal injury & occupational disease) and leads to disablement of the injured person temporarily or permanently which may be partial or total disablement of the injured person for a period extending beyond the day or shift of occurrence of accident.

- **Fatal**

  An accident having the capability of causing death.

- **Non-fatal**

  An accident incapable of causing death.

- **Non-Reportable Accident**

  The accident which are not reported to inspector of factories. This accident is called Non-reportable accident.

- **Unsafe Acts**

  Unsafe act is a human action resulting in an accident or injury to him, others or environment or to all.

- **Unsafe Conditions**

  Unsafe condition is created by an unsafe act of a person or act of God or by any agency or due to failure or weakening of any material, structure, situation, condition or system.

- **Disabling Injury (Lost Time Injury)**

An injury causing disablement extending beyond the day of shift on which the accident occurred.

- **Workplace**

  Any physical location in which work related activities are performed under the control of organization.

- **Audit**

  Systematic, independent and document process for obtaining "Audit evidence" and evaluating it objectively to determine the extent to which 'Audit criteria" area fulfilled.

- **Confined Space**

  A workplace having limited opening for ingress or egress making it difficult for the person inside the confined space to escape freely at will. This workplace could be oxygen deficient (less than 19.5%) or oxygen enriched (more than 23.5%) and could have (i) Restricted flow of fresh air, (ii) or contain (a) inflammable gases / vapours (b) or toxic gases (c) or other specified physical hazards which could overcome those working inside the confined space and physically or mentally immobilize the affected person.

- **Hazard**

  Source , situation, or act with potential for harm in terms of human injury or ill health or ill health or a combination of these.

- **Risk**

  Combination of the likelihood of an occurrence of a hazardous event or exposure(s) and the severity of injury or ill health that can be caused by the event or exposure(s).

- **Acceptable Risk**

  Risk that has been reduced to a level that can be tolerated by the organization having regard to its legal obligations and its legal obligations and its SHE policy.

- **Risk Assessment**

  Process of evaluating the risk(s) , taking the adequacy of any existing controls, and deciding whether or not the adequacy of any existing controls, and deciding whether or not the risk(s) is acceptable.

- **Interested party**

Individual or group, concerned with or affected by the SHE performance of an organization.

- **Man –hours Worked**

  The total number of employee –hours worked by all employees working in the premises. It includes managerial, supervisory, professional, technical, clerical and other workers (including contractor labours, security personnel& other casuals).

  `Man-hours worked shall be calculated from the pay roll or time office record including overtime. When this is not applicable, the same shall be estimated by multiplying the total man days worked for the covered by the number of persons engaged multiplied by the man days worked.

- **Man days lost**

  The day on which the injury occurred and the day injured person returned to the work are not to be included as mandays lost, but all intervening calendar days (including Sundays or days off or days of plant shutdown) are to be included .if after resumption of work, the person injured is again disabled for any period arising out of injury which caused his earlier disablement, such subsequent disablement is also to be included in the mandays lost. According to the schedule of charges, a loss of 6000 mandays is taken for death of a person.

- **Incident**

  Work related event (s) in which an injury or ill health or fatality occurred, or could have occurred.

  Note 1: An **accident** is an incident which has given rise to injury, ill health, or fatality.

  Note 2: An incident where no injury, ill health, or fatality occurs may also be referred to as a “near miss”, “near hit”, “close call” or “dangerous occurrence”

  Note 3: An emergency situation is a particular type of incidence.

- **Near Miss Case**

  An incident where no injury, ill health, or fatality occurs

- **Ill Health**

  Identifiable, adverse physical or mental condition arising from and/or made worse by a work activity and/or work related situation.

- **Reportable Lost Time Injury**

An injury causing death or disablement of the injured person for 48 hours or more excluding the shift on which the accident occurred.

- **Dangerous Occurrence**

  An unplanned event, whether or not it is attended by personal injury or disablement, but arising out of-

  Bursting of a plant used for containing or supplying steam under pressure greater than atmospheric pressure.

  Collapse or failure of a crane, derrick, which, hoist, or other appliance used in raising or lowering persons or goods, or any part thereof, or the overturning of a crane/vehicles/equipment's.

  Explosion or fire or bursting out, leakage or escape of any hot/cold substance (molten metal, liquid or gas) causing injury to any person or any room or place in which persons are employed.

  Explosion of a receiver or container used for the storage at a pressure greater than atmospheric pressure of any gas or gases (including air) or any liquid or solid resulting from the compression of Gas.

  Collapse or subsidence of any floor, gallery, roof, bridge, tunnel, chimney, wall, building, excavation or any other structure or formwork or scaffold.

- **Reportable Sick case**

  A sickness case causing disablement of the affected person for 48 hours or more excluding the day of work on which he fell sick.

<u>Terminology under Factories & E.S.I. Act;</u>

- **Factories Act -** Accident which causes injury to person to such an extent that the injured person becomes disabled to work for a period of 48 hrs. or more.
- **E.S.I. Act -** Accidents which causes disablement to the injured person for not less than 3 days (excluding the day of accident) and which arises in course of injured person‘s employment.
- **Disablement -** The disablement means loss of capability of a person to do some work for which he has been employed in industry just before an occurrence of the accident which has resulted into minor injury, serious injury.
- Such disabilities are three types as under;

- **Permanent Partial Disabilities** -This is particularly in nature which reduce earning capacity in every partial disability in which he might he employed before the accident.
- **Permanent Total Disabilities** -This type disablement is of remaining period of life such accident may result into severely injury & makes a worker incapable of working any type of work which he was able to work earlier as such he has the loss of 100% earning capacity such disablement is called Permanent total disability.
- **Temporary Total Disabilities** - This type of disablement is related to the minor injury which can be medically treated and the workers become 100% fit after treatment or after taking rest to certain no. of days. There after he becomes 100% capable of doing the work as he was doing before the injury. In fact he has become temporary disable only for certain no. of days & in those days he has lost 100% of earning.

CHAPTER 8

LITERATURE REVIEW

CHAPTER 8 LITERATURE REVIEW

8.1. OVERVIEW

In this chapter a well descriptive literature study is penned down as per my research work. The current entitled research work is not a special case study rather the outcome of keen investigation from the work of other researchers published in various journals regarding safety performance rating and safety culture.

8.2. PREVIOUS RESEARCH ON SAFETY PERFORMANCE RATING

Hinze et al. (1995) had carried out experience modification rating as correlate of safety performance. Workmen's reimbursement protection is a significant cost element of a labour in construction industry. The labour-intensive value for these insurance premiums is stand and trade-specific so the costs can mismatch considerably between geographic locations and between crafts. Experience modification rating (EMR), is secondhand to conform the expert paid. This modifier is approximately an inducement for firms to toil for valuable safety records, as firms with poor safety records will conclude higher premiums. Examples have been exaggerated to boost clarify the means in which the EMR values are impacted by contradictory variables. Results display graphically how Injury frequency has a larger impact on the EMR computation than does wrath severity.

Jaselskis et al. (1996) developed some methodologies for attaining superiority in safety performance while working in a construction industry. They developed schemes for betterment of workmen at their construction sites regarding safety performance on the analysis of numerical profiles of companies and projects mutually varying levels of safety performance. This check approach compliments essentially of the beforehand safety-related research, which tends to be preferably qualitative in quality, addressing "what" factors are significant for well-being as adjacent "how much" is adequate to achieve helpful safety outcomes.

Hinze and Gambatese (2003) prepared a report on same basic factors that promote safety attitude of speciality contractors. Their research work analysed several practice factors that significantly persuade the safety performance of specialty contractors. Their study was collected of mismatch surveys of three contradictory specialty contractor populations—an alteration of work contractors located basically in southern Nevada, roofing contractors in the state of Florida, and the regional offices of a large, nationwide automated contractor. While there seem contradictions between the surveys in some areas, the study concluded that specialty contractor safety attitude was generally influenced, in object, by an abode of factors.

Leveson (2004) proposed an innovative accident model for engineering safer systems. In his proposal he presented a new accident epitome founded on integral systems explanation concepts. The evaluate of such a epitome provides a theoretical bottom line for the onset of unique new types of accident analysis, hazard analysis, accident prevention strategies including new approaches to designing for safeguard, risk assessment techniques, and approaches to designing attitude monitoring and safety metrics.

Nenonen (2011) collected report about certain lethal accidents at working sites outsourced operations in the production industry. In his report he focussed about typical accidents, the contributing factors, and preventive measures of impossible occupational accidents that occurred in outsourced industry tasks. He further created a interrelationship between several parameters that infringe from accidents that occurred when tasks were performed in-house in the manufacturing industry. He undertake actions implemented in the factory area for or by an organization employed in the production business.

Hinze et al. (2012) introduced the concept of the use of leading indicators to evaluate the construction safety performance. They gave more emphasis on the use of lagging indicators in the construction sites. They relied on the use of leading indicators to evaluate safety performance of workmen during working hours in construction industry, but the use of lagging indicators relate to the safety results of the happenings of injuries of workmen. They suggested some general parameters to be considered while selecting and using operative leading indicators. Their research work demonstrated the magnitude to which leading indicators can be operated to differentiate the evaluation in project safety performances.

Beriha et al. (2012) studied the valuation of safety performance in Indian industries using fuzzy technique. They presented an artificial intelligence consider for fascination of disparate types of accidents (fatal to minor) in an arguable environment. Likelihood of casualty of accidents in the work place is a random wonderment but tentative investment in distant charge such as expenses in health treatment, safety assignment, up-gradation of tools and material, and expenses on safety material and tools make out lead to loss of value in accident rate. The relationship between description of accidents and investment is difficult to maintain because they do not follow any predictable rule rather empathize in a non-linear manner. In such position, vague logic helps to manual inputs and outputs in a practicable manner for building the hypothesis engine so that various types of accidents can be predicted.

Hedlund (2013) conducted a research work on collecting lethal and permanently disable injured workmen at a manufacturing industry in South Africa. According to the administrative system in South Africa accident are recorded in two policies: Firstly from the insurance system but it is too much problematic if time is a major factor. Secondly the legislative system which provides rough data but is time saving. The interpretation of both the systems is not that simple and further the recordings of the two systems are not analogous comeuppance to major scope gap. In their research work they investigated the relationship between these recordings in the two systems. Contrasting report from both systems the recordings of terminal accidents are hinge on to be in accession, comparatively less so for infinitely disabling accidents/incidents. They have further evaluated if effects of the popular pursue of replacing stable workers with contract workers is unmistakable in the WCC statistics – firm conclusions cannot be drained however, due to report shortcomings.

Al-Refaie (2013) has studied some fundamental attributes that imitate the safety performance of workmen in companies in Jordan using structural equation modelling. In his scholarly research he inspects the major role of organizational, safety management, and work group level factors on safety self-efficacy, safety awareness, and safety behaviour in Jordanian companies. He collected survey data of 324. Structural equation modelling was then used for data analysis. His inspection results revealed that management liability, interrelationships harmony, uninterrupted improvement and laborer empowerment significantly influence stability performance. For large-sized companies, top management, interrelationships, stable improvement, good culture, and employee empowerment significantly influence safety discernment and safety behaviour.

Fonseca et al. (2014) had a comparative analysis of various methods for preventing accidents that are common in construction industries starting from its construction site to design in the building industry. The construction deal is solely liable for such of the initial incidences of work-related accidents in Brazil, as readily as in distinct other countries. In contempt of the dissemination of prevention programs and the proposals for developing safety study for the construction deal, construction sites await dangerous and hazardous places.

Hola and Szostak (2014) in their publish had analysed the knowledge of accident situations in the construction industry. The construction industry is permanently characterized by a valuable level of hazards to the period and durability of employees and by a high accident rate. Knowledge relating to the curriculum of the accident process plays a major role in work safety appraisal and in accident prevention.

Guoetal. (2015) in their research study has developed and tested an integrative epitome of construction workers' safety behaviour mutually an attempt to better comprehend the mechanisms by which key safety condition factors (i.e., authority stability liability, social guarantee, and work pressure) and individual factors (i.e., safety development and safety motivation) promote workers' safety behaviour.

CHAPTER 9

METHODOLOGY

9.1. OVERVIEW

The main objective of this research work is to evaluate by method of quantitative monitoring of accidents in construction industries for the past few years (2011-16). Accidental data may serve as an important feedback instrument to measure safety performance. Accidental data are best commonly expressed as rates, per unit time worked or per unit population. Calculation of rates demands number of injuries/accidents and exposures. Frequency rates express injuries in terms of hours of exposure taking into account actual exposure to the risk. Severity rates express the number of days lost in terms of hours of exposure, taking into account the depth of the injury. Incidence rates tell injuries in terms of number of persons exposed to the risk per year. Rates can either be calculated for employees or for workers in comparison do statistics of fatalities and serious injuries which provide more reliable indices of safety performance.

This work focuses on safety performance monitoring or rating. The main purpose is to provide a platform for discussion on the safety performance rating of construction industries with a perspective on limitations of the data available. In this report I have taken data from two different construction industries so as to contrast the safety performance rating and had surveyed the workers of both the industries by preparing a safety culture questionnaire and taking their feedback regarding safety issues between both and to find out the flaws in implementation of safety program and reduce the number of accidents. The aim of this questionnaire; which is especially developed and specified to reflect the challenges the construction industries is to analyse the progressing scenario of safety culture so that it will helpful to appraise the safety performance and improve the safety climate in the construction industries. In this chapter the accident data collected is reviewed by the calculation of the accident indices and a preparation of the questionnaire process is shown by the help of which progress of safety culture can be improvised.

9.2. ACCIDENT INDICES

9.2.1. Frequency Rate

It is defined as the number of impaired accidents resulting from the factories or industrial accidents per million man-hour worked in a year.

Its purpose is to know how often impaired accidents occurs and following formula is used to calculate Frequency Rate.

Formula:

Frequency Rate = $\frac{Number\ of\ reportable\ loss\ time\ injury \times 10^6}{Man\ hours\ worked}$ Eq (1)

9.2.2. Severity Rate

It guides the duration of injuries and is defined as the number of man days lost due to accidents per million man-hours worked. Its purpose is to determine how serious the injuries are, and the following formula is used to calculate the severity rate.

Formula:

Severity rate = $\frac{Many\ days\ lost\ due\ to\ reportable\ loss\ time\ injury \times 10^6}{Man\ hours\ worked}$ Eq (2)

9.2.3. Incident Rate

It is defined as the ratio of total number of accidents/injuries to the number of average person employed per thousand during the period under review. Its purpose is to find out the ratio of number of injuries to number of person employed, and the following formula is used to calculate the incident rate.

Formula:

Incident rate = $\frac{Number\ of\ reportable\ loss\ time\ injury \times 10^3}{Average\ no\ of\ person\ employed}$ Eq (3)

9.2.4. Frequency Coefficient

Its purpose is to know the ratio between the number of accident to the total number of man-hour worked, and the following formula is used to calculate the Frequency Coefficient

Formula:

Frequency Coefficient = $\frac{No\ of\ accidents \times 10^3}{Man\ hours\ worked}$ Eq (4)

9.2.5. Severity Coefficient

Its purpose is to know the ratio between the number of man days lost to the total number of accidents, and the following formula is used to calculate the Severity Coefficient.

Formula:

$$\text{Severity Coefficient} = \frac{Number\ of\ man\ days\ lost}{No\ of\ accidents} \qquad \text{Eq (5)}$$

9.2.6. Safe T Score

Safe T Score is the process by which we can conclude that the safety performance within the industry has improved or not. It can be calculated by using the present and past record of accidents as by taking out the ratio of the past and the current accidents. The following formula is used to calculate the Safe T Score.

Formula:

$$\text{Safe T Score} = sqrt\left(\frac{\frac{Current\ frequency\ rate - past\ frequency\ rate}{past\ frequency} \times 10^6}{Total\ man\ hours\ worked\ in\ current\ year}\right) \qquad \text{Eq (6)}$$

The outcome value resulting as Safe T Score rate of an Industry can be described from the values mentioned as below in Table No 1.

Table 9.1. Safe T Score Table

Safe T Score	**Description**
Between +2 &-2	Change is not significant. There may be random fluctuation only.
More than +2	Record is worsening than it was in the past. Something wrong has happened
Less than -2	Record is improving than it was in the past. Something better has happened.

9.3. DATA COLLECTION

Now this data has been taken from Industry 1.

Table 9.2. Collection Data: From Accident Register and Attendance Register of Industry 1

Sr. No	Year (1^{st} April to 31^{st} March)	Severity of Accident		Type of Accident		Man days lost due to Reportable Accident	Total Man Hour Worked	Avg. No of employee Present in one day	Total No of Accident
		Fatal	Non-Fatal	Reportable	Non-Reportable				
1	2011-12	0	9	0	9	0	1602700	470	9
2	2012-13	0	17	0	17	0	1569150	450	17
3	2013-14	0	12	0	12	0	1444872	421	12
4	2014-15	0	8	0	8	0	1240470	358	8
5	2015-16	0	3	0	3	0	1245244	364	3

Calculation

As chosen serial number 5 from Table. 9.2, For Year 2015-16

Number of Injuries (Accident) in a year = 3

Average number of employees present in one day = 311

Number of reportable Accident = 0

Man days lost due to reportable Accident = 0

Total number of working days in a year = 311

We know that,

Total man hours worked = Average number of employees present in one day × Number of working day in a year × 8

As the working hour per day is 11 hours in Industry 1 and Industry 2 therefore we take 11 instead of 8.

Revised Formula for total Man-hour worked

Total man hours worked = Average number of employees present in one day × Number of working day in a year × 11

Total man-hours worked = (364 × 311 × 11) = 1245244 Man-hours

Now we calculate all the Accident Indices

- Frequency Rate

Frequency Rate = $\frac{3 \times 10^6}{1245244}$ "in a calendar year" -By using Eq (1)

Frequency Rate = 2.41 Indices (per million man hour worked)

- Severity Rate

Severity Coefficient = $\frac{0 \times 10^6}{1245244}$ "in a calendar year" -By using Eq (2)

Severity Coefficient = 0 Man-days (per million man-hours worked)

- Incident Rate

Incident rate = $\frac{3 \times 10^3}{364}$ "in a calendar year" -By using Eq (3)

Incident rate = 8.24 Indices (per million man-hour worked)

- Frequency Coefficient

Frequency Coefficient = $\frac{3 \times 10^3}{1245244}$ "in a calendar year" -By using Eq (4)

Frequency Coefficient = 0.002 Indices (per million man hour worked)

- Severity Coefficient

Severity Coefficient= $\frac{0}{3}$ "in a calendar year" -By using Eq (5)

Severity Coefficient= 0 Man days lost per Injury

By this method all the accident indices are calculated for the year 2011-12, 2012-13, 2013-14, and 2014-15

- Safe T Score

Safe T Score = $sqrt(\frac{\frac{Current\ frequency\ rate - past\ frequency\ rate}{past\ frequency\ \times\ 10^6}}{Total\ man\ hours\ worked\ in\ current\ year})$"in a calendar year"

Safe T Score = $sqrt(\frac{\frac{FR2\ -\ FR1}{FR1\ \times\ 10^6}}{Total\ man\ hours\ worked\ in\ current\ year})$

Where, FR_2 = Frequency Rate for current year 2015-16 (No of Accident = 3)

FR_1 = Frequency Rate for previous year 2014-15 (No of Accident = 8)

FR_2 = 2.41 (From Frequency Rate calculated above for year 2015-16)

$$FR_1 = \frac{8 \times 10^6}{1240470}$$ -By using Eq (1)

FR_1 = 6.45 Indices (per million man hour worked)

By putting the value of FR_1 and FR_2 we get,

$$\text{Safe T Score} = \frac{2.41 - 6.45}{\sqrt{\frac{6.45 \times 10^6}{1245244}}}$$ "in a calendar year"

Safe T Score = -1.775

Similarly by using this above method we can find the Safe T score for rest of the years.

Now this data has been taken from Industry 2.

Table 9.3. Collection Data: From Accident Register and Attendance Register of Industry 2

Sr. No	Year (1^{st} April to 31^{st} March)	Severity of Accident		Type of Accident		Man days lost due to Reportable Accident	Total Man Hour Worked	Avg. No of employee Present in one day	Total No of Accident
		Fatal	Non-Fatal	Reportable	Non-Reportable				
1	2011-12	0	11	2	9	6	580206	177	11
2	2012-13	0	18	3	15	10	555060	174	18
3	2013-14	0	20	1	19	4	540430	170	20
4	2014-15	0	22	2	20	12	541464	168	22
5	2015-16	0	19	1	18	2	460955	145	19

Calculation

As chosen serial number 5 from Table. 9.3, For Year 2015-16

Number of Injuries (Accident) in a year = 19

Average Number of employees present in one day = 145

Number of reportable Accident = 1

Man days lost due to reportable Accident = 2

Total number of working days in a year = 289

We know that,

Total man hours worked = Average number of employees present in one day × Number of working day in a year × 8

As the working hour per day is 11 hours in Industry 1 and Industry 2 therefore we take 11 instead of 8.

Revised Formula for total Man-hour worked

Total man hours worked = Average number of employees present in one day × Number of working day in a year × 11

Total man-hours worked = (145 × 289 × 11)

Total man-hours worked = 460955 Man-hours

Now we calculate all the Accident Indices

- Frequency Rate

Frequency Rate = $\frac{19 \times 10^6}{460955}$ "in a calendar year" -By using Eq (1)

Frequency Rate = 41.22 Indices (per million man hour worked)

- Severity Rate

Severity Coefficient = $\frac{2 \times 10^6}{460955}$ "in a calendar year" -By using Eq (2)

Severity Coefficient = 4.34 Man-days (per million man-hours worked)

- Incident Rate

Incident rate = $\frac{19 \times 10^3}{145}$ "in a calendar year" -By using Eq (3)

Incident rate = 131.03 Indices (per million man-hour worked)

- Frequency Coefficient

Frequency Coefficient = $\frac{19 \times 10^3}{460955}$ "in a calendar year" -By using Eq (4)

Frequency Coefficient = 0.041 Indices (per million man hour worked)

- Severity Coefficient

Severity Coefficient= $\frac{2}{19}$ "in a calendar year" -By using Eq (5)

Severity Coefficient= 0.105 Man days lost per Injury

By this method all the accident indices are calculated for the year 2011-12, 2012-13, 2013-14, and 2014-15

- Safe T Score

Safe T Score = $sqrt(\frac{\frac{Current\ frequency\ rate - past\ frequency\ rate}{past\ frequency\ \times\ 10^6}}{Total\ man\ hours\ worked\ in\ current\ year})$"in a calendar year"

Safe T Score = $sqrt(\frac{\frac{FR2\ -\ FR1}{FR1\ \times\ 10^6}}{Total\ man\ hours\ worked\ in\ current\ year})$

Where, FR_2 = Frequency Rate for current year 2015-16 (No of Accident = 19)

FR_1 = Frequency Rate for previous year 2014-15 (No of Accident = 22)

FR_2 = 41.22 (From Frequency Rate calculated above for year 2015-16)

FR_1 = $\frac{22 \times 10^6}{541464}$ -By using Eq (1)

FR_1 = 40.63 Indices (per million man hour worked)

By putting the value of FR_1 and FR_2 we get,

Safe T Score = $\frac{41.22 - 40.63}{\sqrt{\frac{40.63 \times 10^6}{460955}}}$ "in a calendar year"

Safe T Score = 0.063

Similarly by using this above method we can find the Safe T score for rest of the years.

9.4. SAFETY CULTURE SURVEY

The definition of safety climate, which can be most adequate for this paper, is “Safety climate is regarded as an individual aspect, which is unruffled of two factors: management’s commitment towards safety and workers immersion in safety”. Safety culture describes the system in which safety is administered in the workplace; it often reflects “the attitudes, beliefs, perceptions and values that employees share in relation to safety”.

A supervisory questionnaire has numerous functions. The questions were based on congregated information from germane literature and information from our teaching supervisors, and were structured into seven areas which were adequate as major areas for safety culture in the construction industry.

To ensure the best practicable result it was of great importance to amass a wide range of persons. This included both persons those who are prone to the hazards as well as persons in management positions. It was also necessary that they had high competency about construction safety and safety issues at interfaces.

During the progress of a guiding questionnaire, efforts were made to ensure that none of the questions were of a specific personal type or encouraged whistle blowing. During the interviews we did not experience that any of the persons deprived answering the questions.

9.4.1. Preparation of Questionnaire

The questionnaire was structured into seven areas which comprise further sub-questions to reflect challenges that the construction industry is confronted with.

The 7 areas which are comprised in the questionnaire are as follows:

- Safety awareness and competency
- Safety communication
- Organizational environment
- Management support
- Risk judgment and management reaction
- Safety precautions and accident prevention
- Safety training

The Sample of the Questionnaire is shown in the Figure 1.

Safety Culture Questionnaire

	Always	Never	Sometimes
1. Safety awareness and competency			
a. I am clear about what my responsibilities are for the workplace safety			
b. I understand the safety rules in my job			
c. I can deal with safety problems in my workplace			
d. I comply with the safety rules all the time			
e. When I am at work, I think safety is the most important thing			
2. Safety communication			
a. I am involved in safety issues at work			
b. Co-workers often exchange tips with one another on how to work safely			
c. I often discuss safety issues with my supervisors			
d. I can get safety information from the company			
3. Organizational environment			
a. There is too much work to do without following the safety procedures			
b. Work pace is too fast to follow safety procedures			
c. I have to ignore safety requirements for the sake of production			
4. Management support			
a. Management believes safety is of the same importance as production			
b. Management takes care of safety problems in my workplace			
5. Risk judgment and management reaction			
a. Management acts only after accidents have occurred			
b. I am sure it is a matter of time before an accident occurs in my workplace			
c. There are conflicts between production procedures and safety measures			
6. Safety precautions and accident prevention			
a. My job is quite safe			
b. In those dangerous jobs, there are always measures to prevent accidents			
7. Safety training			
a. I am trained in safety knowledge			
b. Safety training fits my job			

Name : ____________________

Designation: ____________________

Company Name: ____________________

Figure 9.1. Safety Culture Questionnaire

CHAPTER 10

RESULTS AND DISCUSSIONS

10.1. OVERVIEW

In this chapter the upshot result of accident indices as calculated in the previous chapter is discussed. By the result of Safe T Score the safety performance can be measured. To understand the problems associated with it we have analysed the questionnaire as discussed in the previous chapter by which safety climate can be improved as a result of which accident can be reduced leading to better safety performance in the industries. Deduction of analysis of the questionnaire answers in done with the help of a score card which is discussed in this chapter by the help of which we can come to know about where the omission of safety principles are taking place and how it can be amended. For the improvisation of the safety performance some basic safety recommendations are mentioned.

10.2. DATA ANALYSIS

Following are the outcome values of the accident indices which are calculated from the data amassed from the Industry.

CONSTRUCTION INDUSTRY 1

Table 10.1. Evaluated Data: From Accident Register and Attendance Register of Industry 1

Year	Frequency Rate	Severity rate	Incident rate	Frequency Coefficient	Severity Coefficient	Safe T Score
2011-12	5.62	0.00	19.15	0.006	0.00	
2012-13	10.83	0.00	37.78	0.011	0.00	2.758
2013-14	8.31	0.00	28.50	0.008	0.00	-0.923
2014-15	6.45	0.00	22.35	0.006	0.00	-0.717
2015-16	2.41	0.00	8.24	0.002	0.00	-1.775

CONSTRUCTION INDUSTRY 2

Table 10.2. Evaluated Data: From Accident Register and Attendance Register of Industry 2

Year	Frequency Rate	Severity rate	Incident rate	Frequency Coefficient	Severity Coefficient	Safe T Score
2011-12	18.96	10.34	62.15	0.019	0.545	
2012-13	32.43	18.02	103.45	0.032	0.556	2.305
2013-14	37.01	7.40	117.65	0.037	0.200	0.591
2014-15	40.63	22.16	130.95	0.041	0.545	0.438
2015-16	41.22	4.34	131.03	0.041	0.105	0.063

10.2.1. GRAPHICAL REPRESENTATION

The following Graphs show the disparity of accident indices for both the industries.

The total number of accidents for industry 1 is 9, 17, 12, 8, 3 comprising average number of employees 470, 450, 421, 358, 364 for the years 2011-12, 2012-13, 2013-14, 2014-15, and 2015-16 respectively and the total number of accidents for industry 2 is 11, 18, 20, 22, 19 comprising average number of employees 177, 174, 170, 168, 145 for the years 2011-12, 2012-13, 2013-14, 2014-15, and 2015-16 respectively as shown in figure 10.1.

By analysing the data it was observed that in spite of having more average number of employee than the industry 2, the number of accidents per year is less in industry 1 than as compared to Industry 2.

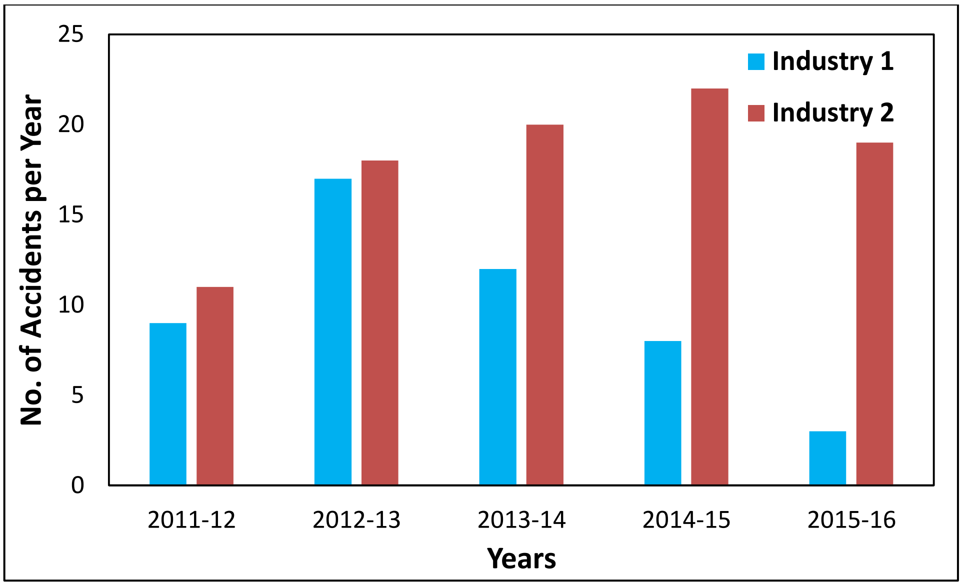


Figure 10.1. Graphical overview of No of Accidents per Year of Industry 1 w.r.t industry 2

The frequency rate of the industry 1 is 5.62, 10.83, 8.31, 6.45, 2.41 and for the industry 2 is 18.96, 32.43, 37.01, 40.63, 41.22 for the year 2011-12, 2012-13, 2013-14, 2014-15, and 2015-16 respectively as shown in figure 10.2. We can observe that the frequency rate for industry 1 has increased from the year 2011-12 to 2012-13 and further there is gradual decrease in FR throughout the next 3 years as shown in figure 2 which indicate that the safety system has improved in the last 3 years.

In case of industry 2 the frequency rate is constantly increased which specifies the safety system need to be improvised.

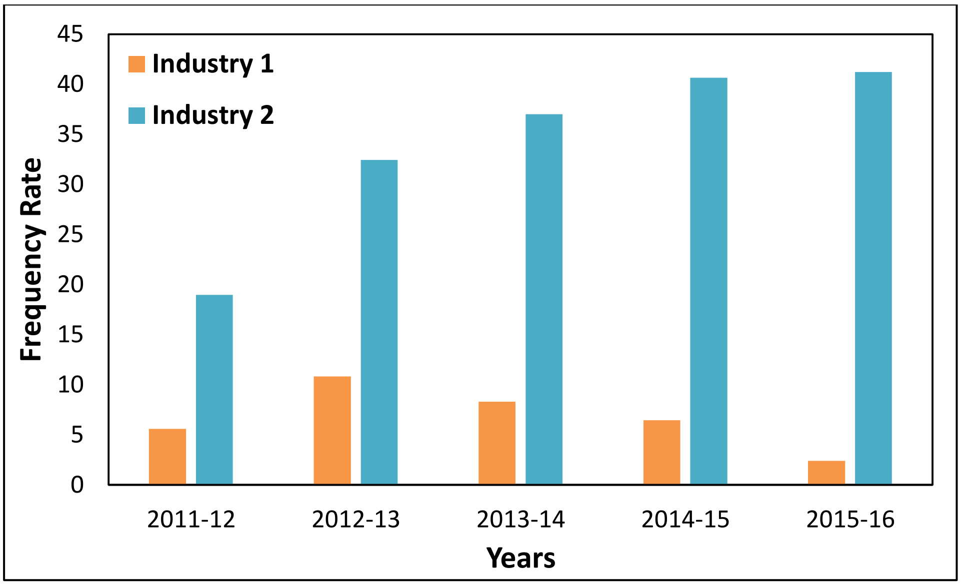


Figure 10.2. Graphical overview of No of Frequency Rate of Industry 1 w.r.t industry 2

The severity rate of industry 1 is found constant as shown in figure 10.3 as 0 for all the years because there is no man days lost due to reportable accidents in the past years and in case of industry 2 there is a random fluctuation of severity rate having the value 10.34, 18.02, 7.40, 22.16, 4.34 for the years 2011-12, 2012-13, 2013-14, 2014-15, and 2015-16 respectively as shown in figure 3. The severity rate in the year 2014-15 is recorded high than others.

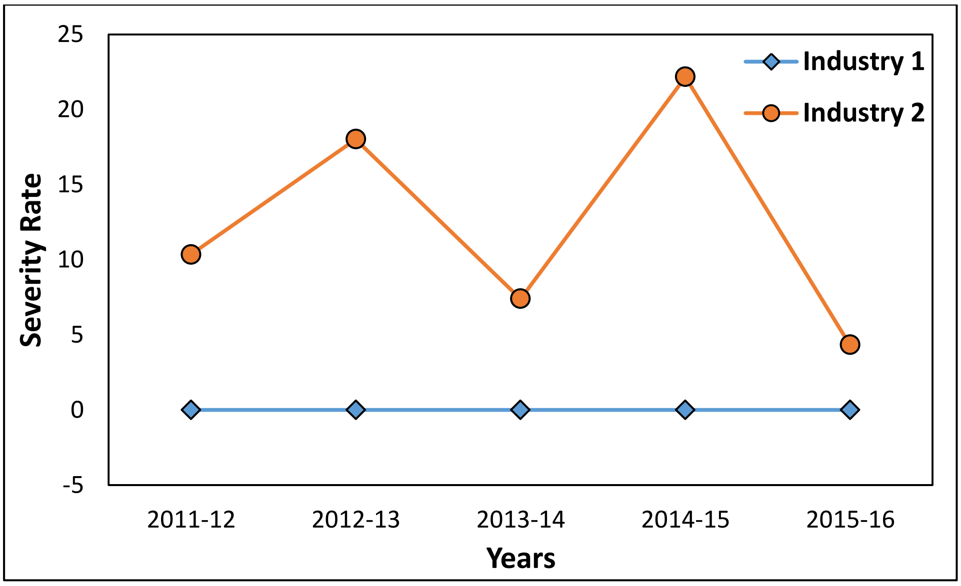


Figure 10.3. Graphical overview of No of Severity Rate of Industry 1 w.r.t industry 2

The Incident rate of industry 1 is 19.15, 37.78, 28.50, 22.35, 8.24 in the years 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 respectively and its value is maximum in the year 2012-13 recorded as 37.78 and it has further decreased for the next 3 years as shown in figure 10.4 and in case of incident rate the values for industry 2 is 62.15, 103.45, 117.65, 130.95, 131.03 for the years 2011-12, 2012-13, 2013-14, 2014-15, 2015-16 respectively. The rate has constantly ascended in the next years, having the maximum 131.03, which express the ratio of total number of injuries to the number of average person employed per thousand has been increasing.

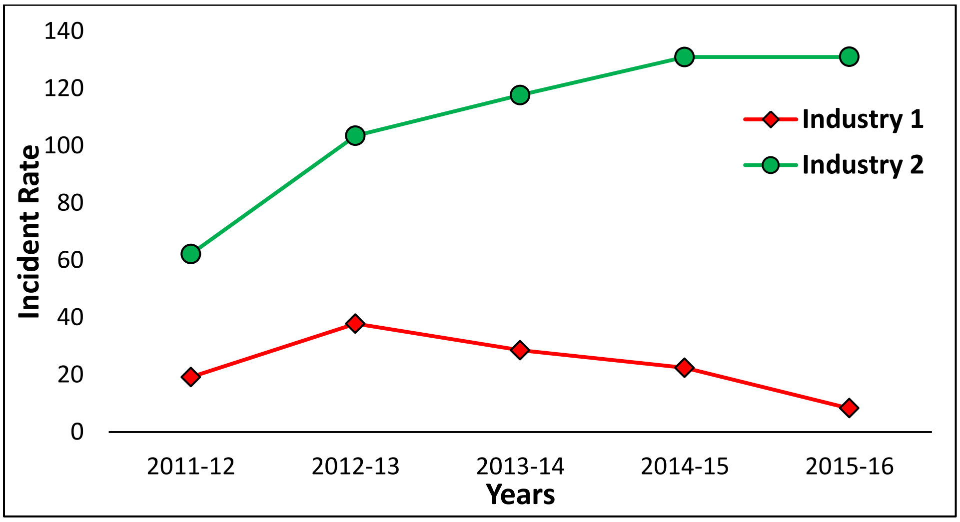


Figure 10.4. Graphical overview of No of Incident Rate of Industry 1 w.r.t industry 2

The Safe T Score graph describes the progress of safety culture in the industries and by the value of which we can understand the flaws and find out the remedies to improvise the safety system.

The STS of industry 1 are 2.758, -0.923, -0.717, -1.775 for the years 2012-13, 2013-14, 2014-15, 2015-16 respectively, where we find that in the year 2012-13 the value of STS is maximum which describes that the record was not good and the improvisation was necessary according to table 1, then the values are found to be gradually decreased throughout next year's as obtained a minimum value of -1.775 as shown in figure 10.5 in the year 2015-16 as compared to previous years.

In case of industry 2 the STS value is randomly fluctuated having 2.305 in the year 2012-13 as the maximum value among rest of the years and it has gradually decreased to a minimum value 0.063 in the year 2015-16, but then again if we compare the STS value of both the industries we can easily say that the safety performance of industry 1 is quite better than industry 2.

However the STS values of industry 2 is mostly between -2 to +2, which signifies that it is a random fluctuation and the change is not significant according to table 1, but an industry shall always try to have their STS value below -2 which indicates comprising best safety climate, so to achieve that result a safety culture questionnaire as shown in table 4 was interviewed and is further analysed is done in this chapter.

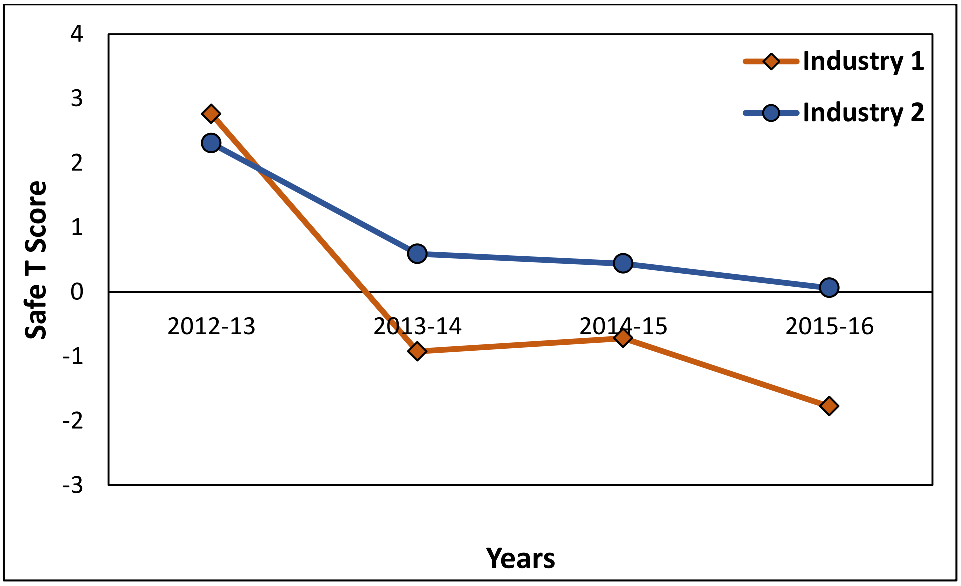
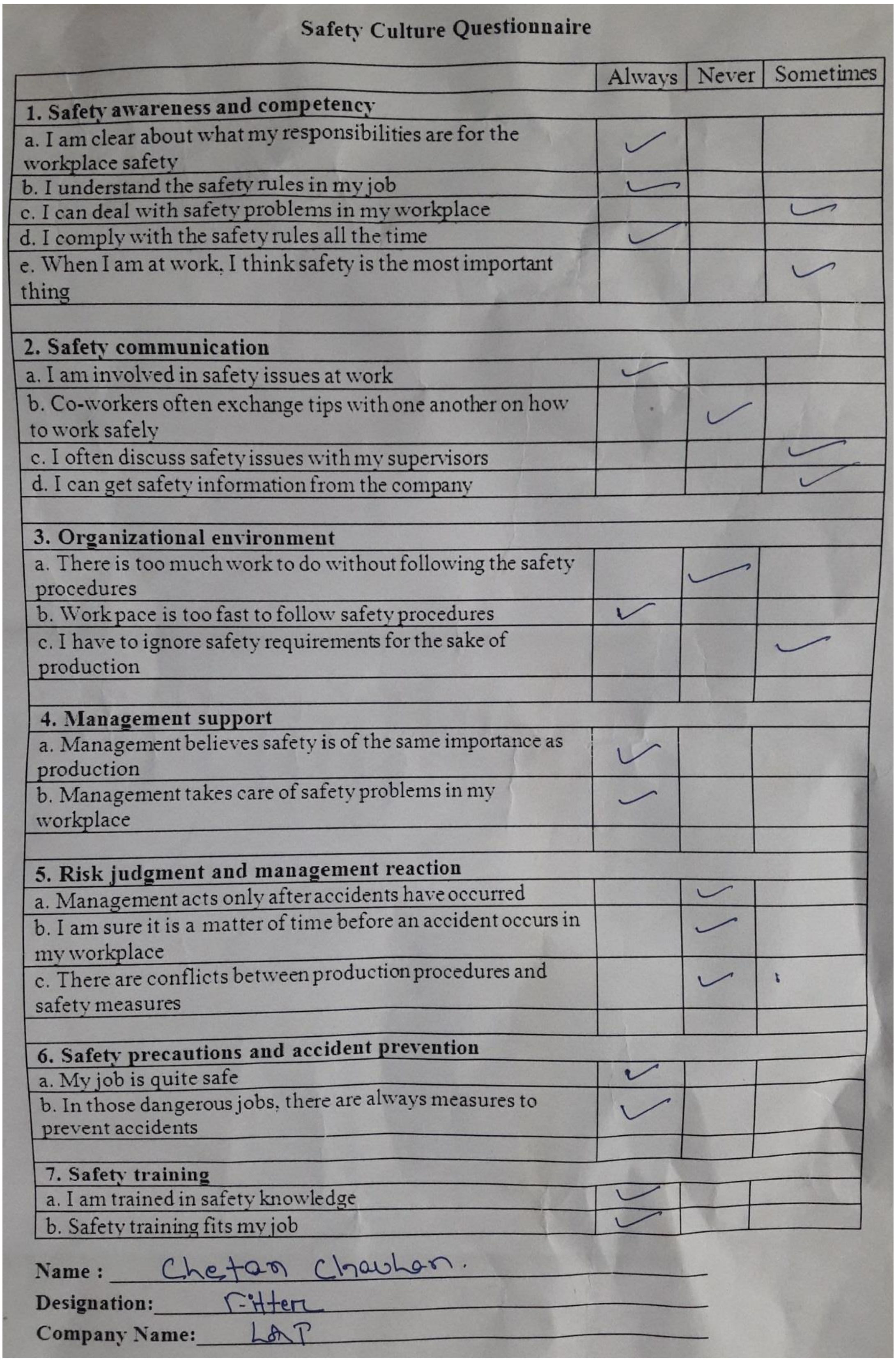


Figure 10.5. Graphical overview of No of Safe T Score of Industry 1 w.r.t industry 2

10.3. SAFETY CULTURE ANALYSIS

The safety culture analysis is based on the survey done as referred in section 3.4 in the previous chapter, with the help of the questionnaire whose sample response filled up by worker of industry 1 and industry 2 is provided in figure 10.6 and figure 10.7.

According to the response of the workers/employees a score card for each company is done to find out the safety culture. The questionnaire had questions which are asked trickily so as to bring out the real answers from the workers/employees.



Safety Culture Questionnaire

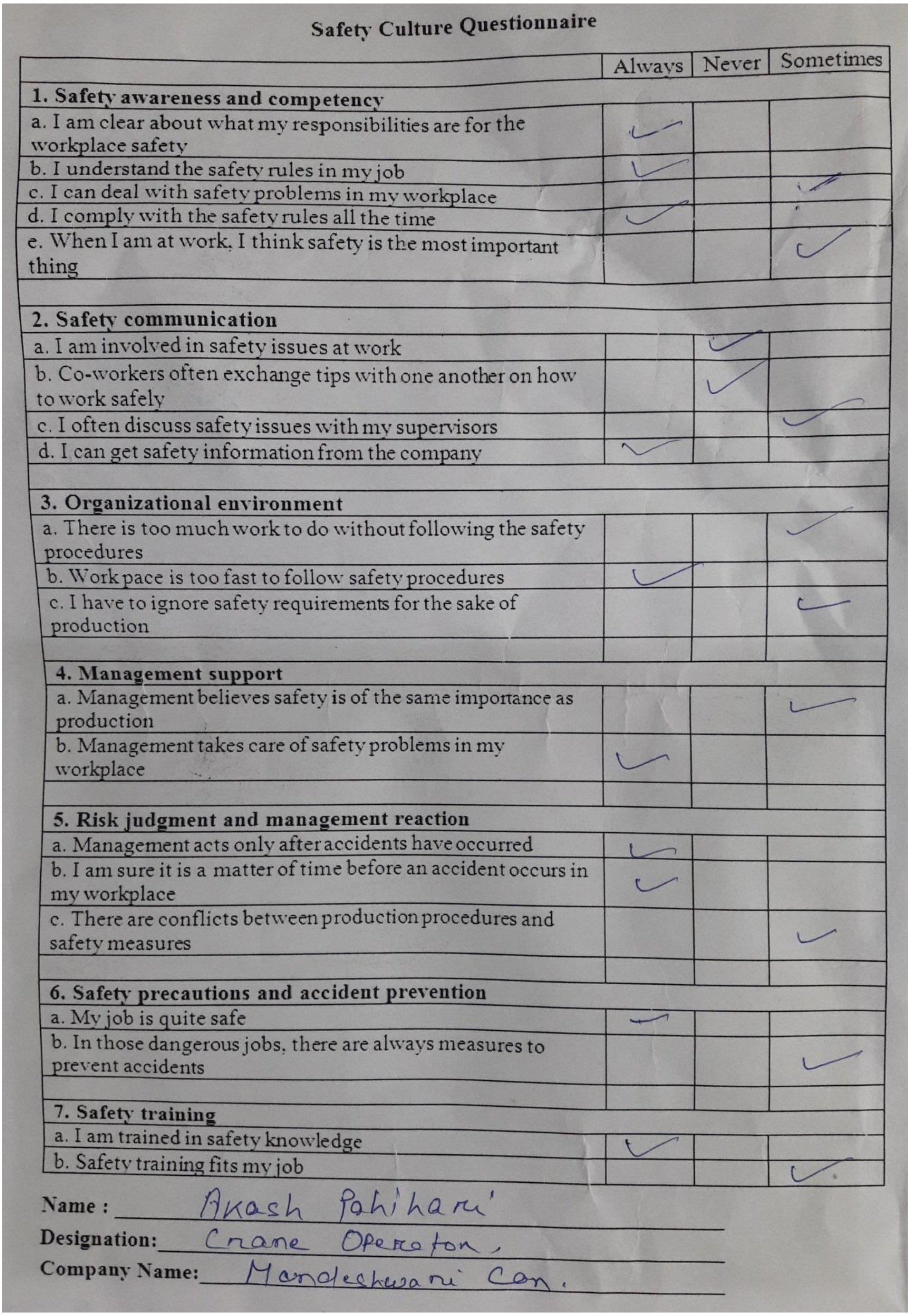
	Always	Never	Sometimes
1. Safety awareness and competency			
a. I am clear about what my responsibilities are for the workplace safety	✓		
b. I understand the safety rules in my job	✓		
c. I can deal with safety problems in my workplace			✓
d. I comply with the safety rules all the time	✓		
e. When I am at work, I think safety is the most important thing			✓
2. Safety communication			
a. I am involved in safety issues at work	✓		
b. Co-workers often exchange tips with one another on how to work safely		✓	
c. I often discuss safety issues with my supervisors			✓
d. I can get safety information from the company			✓
3. Organizational environment			
a. There is too much work to do without following the safety procedures		✓	
b. Work pace is too fast to follow safety procedures	✓		
c. I have to ignore safety requirements for the sake of production			✓
4. Management support			
a. Management believes safety is of the same importance as production	✓		
b. Management takes care of safety problems in my workplace	✓		
5. Risk judgment and management reaction			
a. Management acts only after accidents have occurred		✓	
b. I am sure it is a matter of time before an accident occurs in my workplace		✓	
c. There are conflicts between production procedures and safety measures		✓	
6. Safety precautions and accident prevention			
a. My job is quite safe	✓		
b. In those dangerous jobs, there are always measures to prevent accidents	✓		
7. Safety training			
a. I am trained in safety knowledge	✓		
b. Safety training fits my job	✓		

Name : Chetan Chauhan.

Designation: Fitter

Company Name: L&T

Figure 10.6. Response sample of questionnaire of Industry 1



Safety Culture Questionnaire

	Always	Never	Sometimes
1. Safety awareness and competency			
a. I am clear about what my responsibilities are for the workplace safety	✓		
b. I understand the safety rules in my job	✓		
c. I can deal with safety problems in my workplace			✓
d. I comply with the safety rules all the time	✓		
e. When I am at work, I think safety is the most important thing			✓
2. Safety communication			
a. I am involved in safety issues at work		✓	
b. Co-workers often exchange tips with one another on how to work safely		✓	
c. I often discuss safety issues with my supervisors			✓
d. I can get safety information from the company	✓		
3. Organizational environment			
a. There is too much work to do without following the safety procedures			✓
b. Work pace is too fast to follow safety procedures	✓		
c. I have to ignore safety requirements for the sake of production			✓
4. Management support			
a. Management believes safety is of the same importance as production			✓
b. Management takes care of safety problems in my workplace	✓		
5. Risk judgment and management reaction			
a. Management acts only after accidents have occurred	✓		
b. I am sure it is a matter of time before an accident occurs in my workplace	✓		
c. There are conflicts between production procedures and safety measures			✓
6. Safety precautions and accident prevention			
a. My job is quite safe	✓		
b. In those dangerous jobs, there are always measures to prevent accidents			✓
7. Safety training			
a. I am trained in safety knowledge	✓		
b. Safety training fits my job			✓

Name : Akash Pahihari

Designation: Crane Operator,

Company Name: Mandeshwari Con.

Figure 10.7. Response sample of questionnaire of Industry 2

A total of 13 facets have been analysed in the score card which directly or indirectly dependent on the responses of the questionnaire given in figure 9.1.

Each facet is analysed by the different levels of safety culture i.e. Denial, Reactive, Rule base, Proactive and Ideal. A weighing factor is allocated to each level of safety culture such as 1 for Denial, 2 for Reactive, 3 for rule based, 4 for Proactive and 5 for Ideal.

The following table 10.3 illustrates the questions that are used to understand the facets of the score card from the questionnaire. The facets in the score card table are as referred to as in the questionnaire.

Table 10.3. Linkage between score card facets and Questionnaire

Serial Number of Facets	Questionnaire Question
1	4-a, 4-b, 5-a
2	1-d, 1-e, 5-c
3	2-b, 2-c, 2-d
4	1-b, 1-d
5	3-a
6	1-a, 1-b, 1-e
7	2-c, 2-d, 4-b
8	7-a, 7-b
9	5-a, 5-b, 6-a, 6-b
10	3-a, 3-b, 3-c
11, 12, 13	Self-Analysed

The last 3 questions are analysed according to the researcher's practical knowledge while working closely with both the industries. 46 and 21 responses were collected from industry 1 and industry 2 respectively a score card analysis is done for both the industries separately. In order to analyse the score of a facet, the responses of all the dependent questions in the questionnaire are found out.

For example, the facet 1 of the score card depends on the question 4a, 4b and 5a. Hence the total number of responses for always, never and sometimes in the questionnaire is collected individually for each industry. Hence for the current example, for industry 1 having 46 responses, the total responses for facet 1 would be 138 (46 responses × 3 questions = 138 responses).

Now each equation in the questionnaire could have a positive reply, a deleterious reply or an undecided response. Always, never, and sometimes could be positive, denial, or undecided.

The total percentage of response as positive, denial and undecided is found out for each of the facets of the score card. The score 1 to 5 are divided according to the percentage shown in the table 10.4. The percentage of undecided responses is equally divided as positive and decline. On calculation, according to whichever i.e. positive or decline has higher percentage, the weighted score is given according to the table given below.

Table 10.4. Percentile Divisions of the safety culture levels

Weighing factor	**Levels**	**Positive in %**	**Denial in %**
1	Denial	0 - 20	80 – 100
2	Reactive	20 – 40	60 – 80
3	Rule base	40 – 60	40 – 60
4	Proactive	60 – 80	20 – 40
5	Ideal	80 - 100	0 - 20

Example of score for facet 1 in the score card for Industry 1 and Industry 2.

Table 10.5. Response data of the Questionnaire

Questionnaire Question	Always		Never		Sometimes	
	Industry 1	Industry 2	Industry 1	Industry 2	Industry 1	Industry 2
4-a	29	9	4	5	13	7
4-b	32	14	3	4	11	3
5-a	9	6	32	10	5	5

Calculation (example)

For Industry 1:

Positive = 29 + 32 + 32 = 93

Denial = 4 + 3 + 9 = 16

Undecided = 13 + 11 + 5 = 29

Therefore,

Total positive = 93 + $\frac{29}{2}$ = 107.5

Total Denial = 16 + $\frac{29}{2}$ = 30.5

% of positive response = (Total number of positive response / total number of response) × 100

= (107.5/138) × 100 = 77.89 %

% of Denial response = (Total number of Denial response / total number of response) × 100

= (30.5/138) × 100 = 22.11 %

Hence the positive score fall under proactive as per table 10.4.

For Industry 2:

Positive = 9 + 14 + 10 = 33

Denial = 5 + 4 + 6 = 15

Undecided = 7 + 3 + 5 = 15

Therefore,

Total positive = 33 + $\frac{15}{2}$ = 107.5

Total Denial = 15 + $\frac{15}{2}$ = 30.5

% of positive response = (Total number of positive response / total number of response) × 100

= (40.5/63) × 100 = 64.20 %

% of Denial response = (Total number of Denial response / total number of response) × 100

= (22.5/63) × 100 = 35.71 %

Hence the positive score fall under rule based as per table 10.4.

Here it is required to understand that the positive response for question 4-a and 4-b is Always, whereas for question 5-a is Never and vive-versa for denial.

By using the same process the score is given to all the facets of the score card, the final score card is prepared as shown in Table 9 where the (•) symbol is used for Industry 1 and (♦) symbol is used for Industry 2.

Table 10.6. Safety culture Score card

Score Card				1	2	3	4	5
Description of Facets				**Denial**	**Reactive**	**Rule Based**	**Proactive**	**Ideal**
1	Attitude and Involvement of Management in Safety Issues					♦	●	
2	Prioritization of Safety in Competition with Other Concerns				♦		●	
3	Interest in Communication of Safety Issues						♦	●
4	Rules and Regulations				♦			●
5	Emergency Planning				♦			●
6	How are Benchmarking, Trends and Statistics Used?			♦			●	
7	Co-operation with Authorities						♦	●
8	Ensuring competency training and Skill upgrading					♦		●
9	Performance of Incident and Accident Reporting						♦	●
10	How is Commitment to Procedures and Rules in the Organization?				♦		●	
11	Individual attitudes towards Competing Organizations				♦	●		
12	How is Experience feedback used in the Organization?			♦			●	
13	How are audits and Reviews Performed?				♦			●
	Total Ticks per Column	Industry 1	A	0	0	1	5	7
		Industry 2	B	2	7	2	2	0
	Weighting Factor		C	1	2	3	4	5
	Number of ticks per column(A) × Weighing Factor(B) Sum of Total Weighted Scores, Total = A × B	Industry 1		0	0	3	20	35
		Industry 2		2	14	6	8	0
	Calculated Average Safety Culture Score: Total(Sum(A×B))/13	Industry 1		(3+20+35)/13 = 4.46				
		Industry 2		(2+14+6+8)/13 = 2.30				

If the outcome resulting as safety culture score is nearer to 5 then it may be considered as the safety climate industry is in ideal condition. The maximum score that can be obtained in this process is 5 where all the response needs to be ideal level, which will represent the best safety climate progress, and if the score is below 3 it is quite below average where the safety culture needs to be improvised.

So as in this case the Industry 2 is having the safety culture score as 2.30 which desires few recommendations for its progress and it requires quick implementation.

A preferred output from a process like this should be a detailed plan for concrete actions. These actions should thereafter be used as a basis for further evaluations and new discussions to see if the organisation has improved for the selected areas, or not. It is necessary to continuously carry out this process to ensure constantly improvements. Another aspect is that this gives the opportunity to constantly monitor the safety culture status in the organisation.

10.4. RECOMMENDATION FOR INDUSTRY 2

Normal habit of a person or management is to follow this reactive or corrective approach only after an accident. They never think of investing money or time for preventive measures to avoid accidents by advance planning. Drawback of this approach is to suffer some losses due to one or more accidents. In this work approach, action is started after accident. Accident causes are investigated analysed and preventive action is determined. Then it is applied to prevent recurrence of the similar accident. This works as a lesson from the accident. The safety culture in the Industry 1 is sounder than Industry 2 because of its ideal safety activities and practices. Few recommendations are made for Industry 2 after analysing the safety culture which will help to have progress in safety culture in the organisation.

- Key performance indicators and EHS Targets and goals should be fixed by top management of the company.
- SHE performance must be reviewed at various levels.
- Behavioral based safety process must be adopted.
- Regular training program on Occupational Health should be organized to spread awareness among workmen on Occupational Diseases.
- In every shift before the commencement of work, toolbox talks should be

conducted at various locations of the site by concerned engineers and safety staffs.

- Site engineers must accompany the session & the workmen must be briefed about the potential hazards and risks of the day's work and safe work methods.
- Best safety conscious workmen of the month should be awarded in monthly safety committee meeting.
- The site safety supervisors should also be awarded monthly, based on their performance for identifying unsafe act and unsafe conditions of the work site.
- After various notices & discussions in the meeting, if any subcontractor or workmen continue to fail to implement EHS norms, a penalty should be issued to the concerned so as to force him for EHS implementation.
- Risk Assessment of each and every activity of the project including routine and non-routine activities should be mandatory.
- Risks involved in the activity should be analysed and the control measures must be identified for each and every activity.
- All workmen and staff members should be given a one-day Health, Safety and Environment Induction.
- Apart from the routine work as engineer, site engineers i.e. employees should be designated for specific EHS Roles and Responsibilities. This must be well documented and defined in site EHS Plan.
- Based on the EHS Roles and Responsibilities training programs should be conducted for the engineers to make the staff more competent.
- Posters and signboard related to occupational Safety and Health should be displayed at all conspicuous locations of the site. The information of display boards and posters should be kept in local languages to spread the messages in all workmen.
- For incident investigation site should have incident investigators trained and certified by external agency for incident /accident investigation.
- All accidents, incidents, near misses and dangerous occurrences should be investigated and contributory causes must be determined. Corrective and preventive action plan should be prepared based on the direct causes & root causes.

- Management Review meeting at site should be held annually.
- EHS Managers / Engineers review meets should be organized monthly to take feedback on various safety, health and environmental issues.

CHAPTER 11

CONCLUSIONS

- At first the accident indices were calculated i.e. frequency rate, severity rate, and incident rate from the accidental data collected for past 5 years i.e. 2011-16 from both the industries from which it was concluded that the accident indices in case of industry 2 is higher than the industry 1 and safety improvement was needed in industry 2.

- The safe T Score was calculated for both the industries from which it was found that the STS value of industry 1 was quite less than as compared to industry 2. The minimum the STS value the better is the safety system. The STS values found for industry 1 was in negative integer whereas the values of STS in case of industry 2 was in positive integer which signifies that the safety system is quite better in industry 1 than as compared industry 2.

- A safety questionnaire was set to understand the progress of safety culture in the industries which was further analysed by safety culture score card. The facets in the safety culture score card were linked with the answers of the questionnaire which were answered by the members of the industries. The safety culture score card contained different safety culture levels each having some specific weighted score. The safety culture score for industry 1 was higher closer to 5 than the industry 2 signifying that the industry 1 is having better safety climate and it is necessary for industry 2 to improve its safety culture.

- Further for the improvement of the safety culture in industry 2 some recommendations are made which may help industry 2 to increase its safety performance within its organisation.

- The process adopted in this thesis can be used by any industry to evaluate their safety performance which will help them to improve their safety system. The process of evaluating safety culture by using safety culture questionnaire and safety culture score card will help different industries to improve safety climate within the organisation.

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